Analysis of Aviation Research and Development Programs with Respect to the Level I Concepts of Operation

NASA RTO-2: NAS2-98005

"Global Gap Analysis of Operational Requirements Derived from Future Operational Concepts for the National Airspace"

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1   INTRODUCTION

1.1   OBJECTIVE

This is the report of the results for NASA contract NAS2-98005, "A Global Gap Analysis of Operational Requirements Derived from Future Operational Concepts for the National Airspace System". The objective of this study was to map the "*Air Traffic Services Concept of Operations for the NAS in 2005-Narrative*" [1] (here after referred to as the Narrative), with research and development programs and find the gaps and overlaps in research.

1.2   PROGRAM OVERVIEW

The main body of this work concentrates on the FAA's Research Program Descriptions (RPD), MITRE, and NASA's research programs and tools. This report provides an accumulation of research and development program data, an analysis methodology, analysis and mappings of the data, and assessments of gaps and overlaps in research.

The programs from the FAA's *1997 Aviation System Capitol Investment Plan (CIP)*[3] were not included in this analysis. The CIP concentrates on already existing technologies that have been validated and tested for implementation, whereas the focus of this analysis was of the ongoing research and development of new technologies. These programs will then potentially be part of the CIP in the future. This is clarified by the following statement extracted from the CIP; "…R,E&D is investigating new technologies required for the FAA to meet its mission in the 21st century. The R,E&D effort will accomplish concept exploration and demonstration of new technology initiatives. After prototype systems have proven technologically feasible and operationally beneficial, the responsibility for acquisition moves to the CIP. Thus, through the interrelated CIP and R,E&D Plan, the FAA will institute projects to achieve operational benefits for the entire aviation community." (P.32 CIP)

The Narrative and the corresponding "*Air Traffic Services Concept of Operations for the National Airspace System in 2005 - Operational Tasks & Scenarios,*"[3] the Addendum, guide the definition of research programs directed by the FAA and other organizations, institutions, universities, and companies. The eight sections of the Narrative have been organized into a hierarchy of requirements in the Level I CONOPS (Appendix C). The Level I CONOPS identifies specific concepts of operation (CONOP) with one or more sentences directly from the Narrative. The mapping results are between programs and these developed Level I CONOPS.

The analysis approach entailed an independent categorization of each program, thereby providing a convenient way of briefly disclosing the major emphasis of a program. This categorization then allowed the researcher to quickly focus attention on related CONOPS and map the program to the CONOPS from the Narrative. The mappings were then analyzed to identify the CONOPS that had

gaps and overlaps with respect to the documented intent of the various research programs. There are no judgements of the relative merit of any program, nor judgements related to the need to fill a gap or resolve an overlap.

While mappings and associated analysis are the main result of this effort, the methodology and tools developed for establishing the mappings are also significant. The goal of mapping any available research program to the Narrative is now readily achievable.

A database engine has been developed which allows the researcher to find related material using an indexed search engine. This engine, called CRTS (CONOPS and Requirements Tracking System), has been developed as an Intranet tool. It is possible, for example, to make this tool and all of the database available on the World Wide Web with a few modifications to the "web page" solution developed for this database engine.

2 ANALYSIS METHODOLOGY

2.1 DATA COLLECTION

The goal of the data collection process was to gather research and development program descriptions from cooperative sources. Several sources and avenues were used in forming an Industry and Academic contact list that included the FAA's *Capitol Investment Plan (CIP)*[2], Internet searches, personal contacts, and Aviation Week & Space Technology's *Aerospace Source Book 1997*[4]. A cover letter requesting program information was prepared and sent to 132 potential contributors from the contact list. Due to the proprietary nature of research programs and institutional policies, most sources were unable to accommodate the request for information. Appendix G contains the complete contact list.

The documents were provided by the following sources:

FAA: Research Program Descriptions (RPD)
- Fiscal year 1999 (30 programs)
- Fiscal year 2000 (39 programs)

Mitre: Program descriptions
- Fiscal year 1998 (49 programs)
- Fiscal year 1999 (77 programs)

NASA:
- AATT (11 programs)

Eurocontrol:
- 222 programs

Table 1 summarizes the level of contacts made for both Industry and Academia.

Table 1: Industry and Academia Contact Summary

Industry Contacts			Academic Contacts		
Contact Type	Total Distribution	Total Response	Contact Type	Total Distribution	Total Response
U.S. Mail	27	0	U.S. Mail	5	0
Electronic Mail	50	5	Electronic Mail	50	6

2.2 DATA ANALYSIS METHODS

Figure 1 describes the gap/overlap analysis methodology. This process consists of eight steps. Steps one, two and three (the left upper branch in Figure 1) includes the preparation and categorization of the Level I CONOPS. Steps four and five are the collection and categorization of ongoing programs that support the Air Traffic Services. In the Mapping (step six), these two branches are combined by developing a relationship, or mapping, between the programs and Level I CONOPS. The categorization results were central to this step. The subsequent subject matter expert (SME) evaluations (step seven) of these mappings provides a collection of judgements which are finally assimilated in the Gap / Overlap Analysis (step eight). Details on each of the eight steps follow.
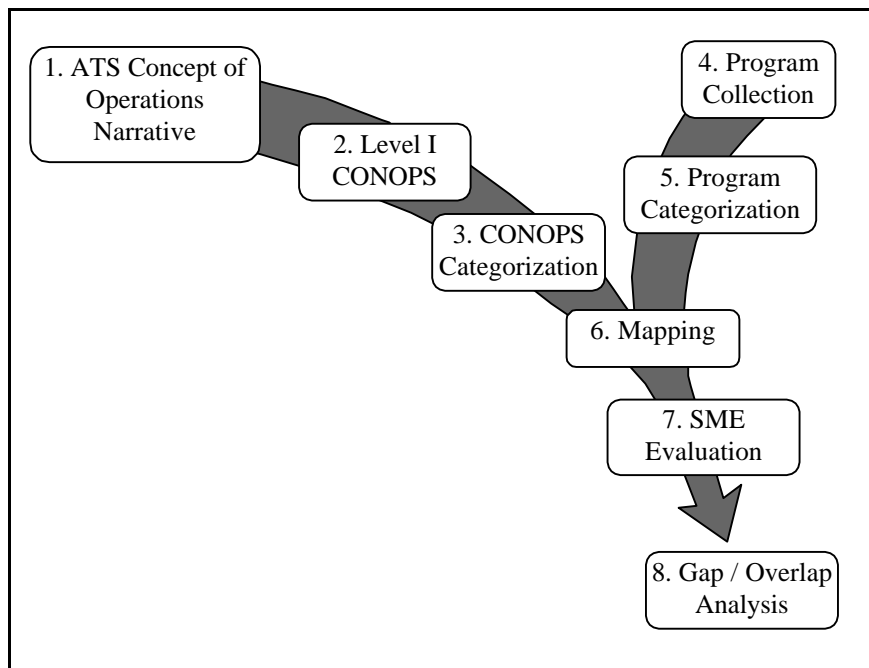
Figure 1: Gap/Overlap Analysis Flow Down

Step 1: The Narrative was developed and published September 1997 by the FAA. The Narrative is the result of a joint government and industry study of how the National Airspace System should evolve between the present status and the eventual "Mature Stage" of Free Flight. The Narrative addresses the complex issues of modernization through identifying, by domain, some of the necessary operational goals.

Step 2 and 3: Verbatim phrases and sentences from the Narrative were organized into a hierarchy called the "Level I CONOPS." These CONOPS were categorized by Narrative paragraph number (called domain) and function as shown in Table 2. The definitions of the categories are available in Appendix B.

Table 2: Categorization of CONOPS and Programs is a Basis for Mapping

Functions (CONOPS and Programs)	Domains (CONOPS and Programs)	Systems (Programs only)	Areas (Programs only)
• Communication • Navigation • Surveillance • Weather • Automation • Maintenance and Facilities	• Introduction and Overall • Flight Planning • Airport Surface • Departure and Arrival • En Route / Cruise • Oceanic Operations • NAS Management • Management	• Ground • Airborne • Space	• Human Factors • Performance • Economic Impact • Other

Step 4: Step four entailed surveying ongoing research and development programs. The collection of programs that could contribute to the ATS concept of operations was sought from the FAA, Federally Funded Research and Development Companies (FFRDC, including MITRE and Lincoln Laboratory), Universities, Industry, and Eurocontrol.

Step 5: Step five was categorization of the programs using the same breakout as derived for the CONOPS (see Table 2). The systems and areas were added to the categorization listings. These new categories were included to succinctly characterize the program emphasis for later analysis. Program categorization entailed assessments with the rating system shown in Table 3 (below). The results of the categorization process appear in Appendices C and D. A histogram (Figure 2) is included for perspective on the distribution of ratings.

Table 3: Categorization Rating Definitions

Rating	Definition
Y#	very significant impact on category
Y+	significant impact on category
Y	impacts category
Y-	insignificant impact on category
Y=	very insignificant impact on category
N	not related

Score Distribution for Program Categorization
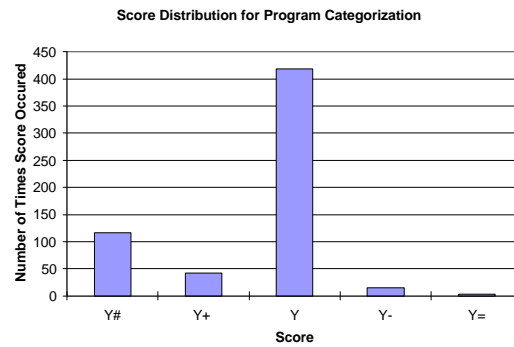
Figure 2: Histogram of Categorization Ratings

Step 6: Step six was the mapping process that is illustrated in Figure 3. The process begins with the set of 390 categorized Level I CONOPS and 129 categorized programs. The process was streamlined to eliminate most of the non-matches by using the categorization results from steps three and five. The potential mappings are the collection of Level I CONOPS and program pairs which result from the use of the categorizations. (i.e. matched domains and functions)

Categorized Program List (step 5)

Categorized Level I CONOPS (step 3)

Analysis (step 6)

Potential Mappings

Validated Matches
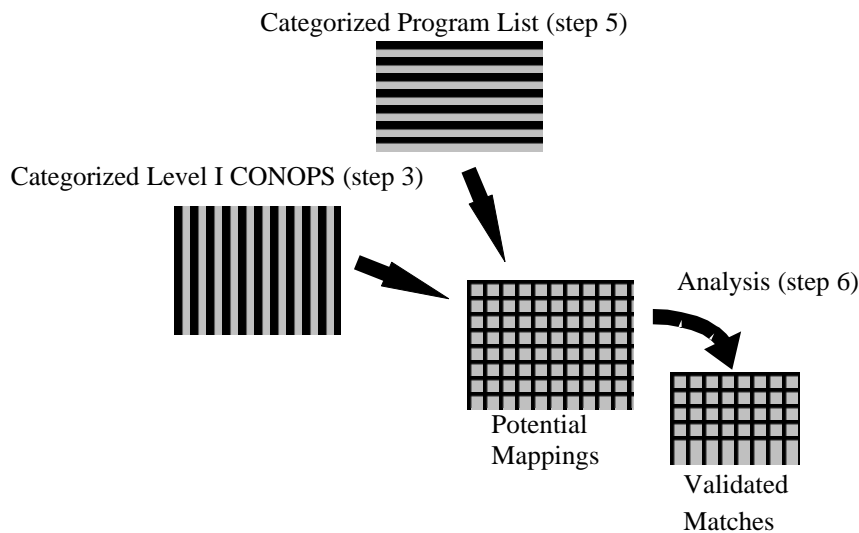
Figure 3: Program to Level I CONOPS Matching Process

As an example, in Table 4, CONOP Y matches Program X in one function, Communication, and one domain, Airport Surface. Therefore, Program X will be studied against all CONOPS from the Narrative Chapter 3, Airport Surface. The categorization ratings in Table 4 are defined in Table 3.

Table 4: Categorization Matching Example

	Categories	CONOP Y	Program X	
Functions	Communication	Y	Y	**function match**
	Navigation			
	Surveillance	Y		
	Weather	Y		
	Automation		Y-	
	Maintenance & Facilities			
Domains	General	Y		
	Flight Planning			
	Airport Surface	Y	Y	**domain match**
	Departure / Arrival	Y		
	En Route / Cruise		Y#	
	Oceanic Ops			
	NAS Management			

The mapping results are in Appendix E and F. The scoring system shown below was used to identify the significance of a mapping. The histogram of ratings shown in Figure 4 below, shows the frequency of score occurrence.

Table 5: CONOPS to Programs Rating Definitions

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications
N	no, the program does not fulfill the CONOP
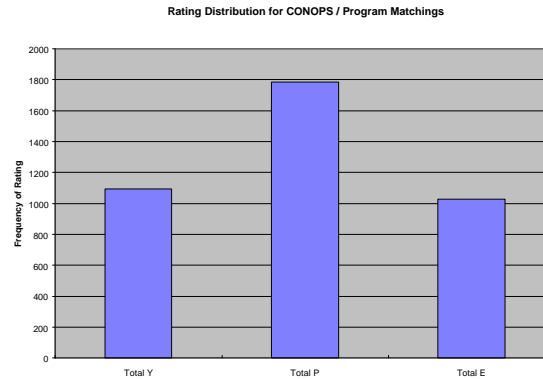
Figure 4: Histogram of CONOPS to Programs Ratings

Step 7: Step seven begins with a set of "potential mappings" based on domain and function matches between the CONOPS and Programs. From here, an analyst must evaluate all of the requirements with the program matched. A final set of "validated matches" results.

Step 8: Step eight involves breaking out the validated matches into useful sets of data, so that gaps and overlaps may be determined.

2.3 DATA ANALYSIS TOOLS

Microsoft Excel

A number of tools were used in the analysis process. MS *Excel* was used to compile and organize the data and evaluations into spreadsheets. MS *Excel* had the capabilities to edit the data easily, and finally to sort the data once it was scored.

CRTS (CONOPS and Requirements Tracking System)

A database engine has been developed which allows the researcher to find related material using an indexed search engine. This engine, called CRTS (CONOPS and Requirements Tracking System), has been developed as an Intranet tool. It is possible, for example, to make this tool and all of the database available on the World Wide Web with a few modifications to the "web page" solution developed for this database engine.

3   ANALYSIS RESULTS

3.1   ACCUMULATED RESULTS OF MAPPINGS

The average number of program hits per Level I CONOP is shown in Figure 5. A program "hit" is defined to be a mapping between a program in a given paragraph and a CONOP with a score of (Y)es, (P)artial, (E)xtensible (defined in Table 5). If a program satisfies multiple Level I CONOPS in a particular chapter, the chapter will accumulate multiple hits from that program.

Although Figure 5 seems to indicate that every chapter is well-covered by programs, a closer examination per CONOP is necessary. Figure 5 shows the average number of programs per CONOP, thereby giving a sense of where concentration of programs occurs. Therefore, while some CONOPS are covered by many programs, some CONOPS are not covered by any. Also, all program hits are shown, whether or not it was a yes, partial, or extensible.
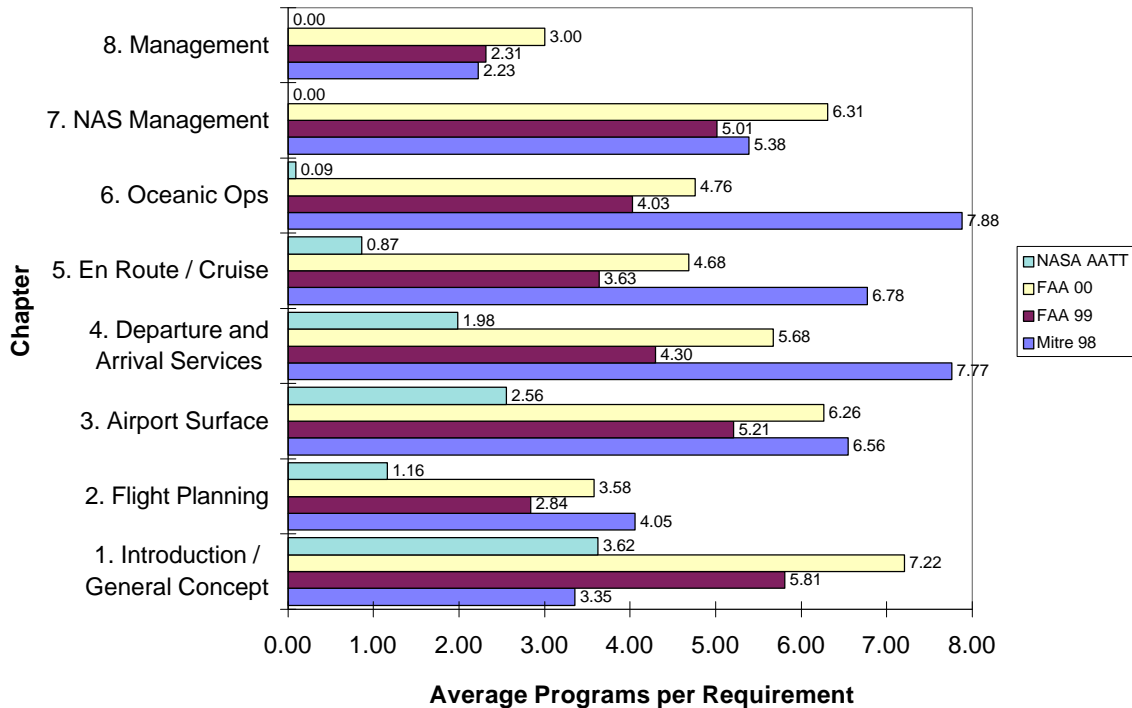
Figure 5: Average Number of Programs per CONOP Chapter

3.2   RESULTS BY CHAPTER

The bar graphs in this section provide more detailed information with respect to the number of programs that are applicable to each CONOP. Each graph represents the CONOPS from a chapter. In this way, specific Level I CONOPS can be identified that are neglected by programs or supported by multiple programs. Detailed listings of programs that match each CONOP are contained in Appendix E.

3.2.1 CHAPTER 1: INTRODUCTION TO THE NARRATIVE

Figure 6 summarizes mappings of all programs to Chapter 1 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred. Chapter 1 is an introductory chapter, so many of the CONOPS that were produced from the chapter are broad. Therefore, many of these broad Level I CONOPS matched to programs.

Figure 7 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications

Figure 6: Programs per CONOP Chapter 1
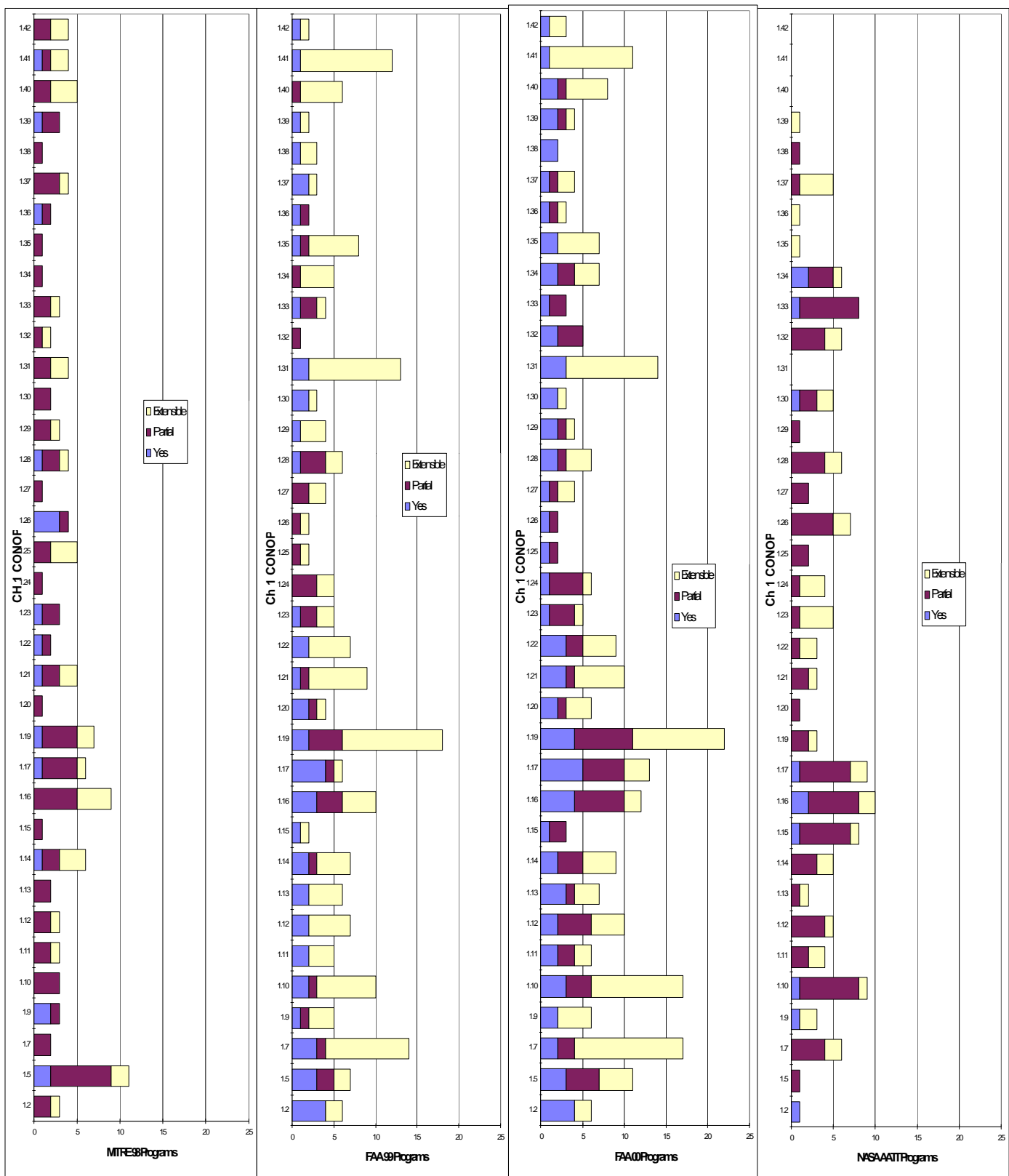
Figure 7: Chapter 1 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

3.2.2 CHAPTER 2: FLIGHT PLANNING OPERATIONS & SERVICES

Figure 8: Programs per CONOP Chapter 2

Figure 8 summarizes mappings of all programs to Chapter 2 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred. This chapter covers the processes, hardware, software, and infrastructure definitions for pre-flight planning concepts.

Figure 9 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications

Figure 9: Chapter 2 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

3.2.3 CHAPTER 3: AIRPORT SURFACE OPERATIONS AND SERVICES

Figure 10 summarizes mappings of all programs to Chapter 3 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred.

Figure 11 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications

Figure 10: Programs per CONOP Chapter 3

Figure 11: Chapter 3 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

3.2.4 CHAPTER 4: DEPARTURE AND ARRIVAL SERVICES
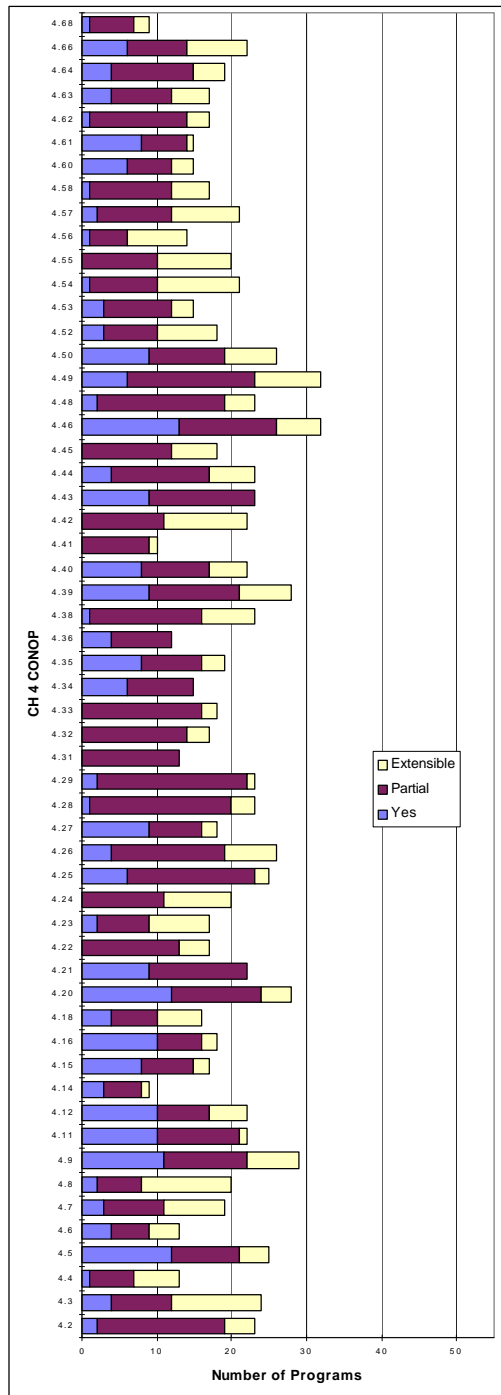
Figure 12: Programs per CONOP Chapter 4

Figure 12 summarizes mappings of all programs to Chapter 4 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred.

Figure 13 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications
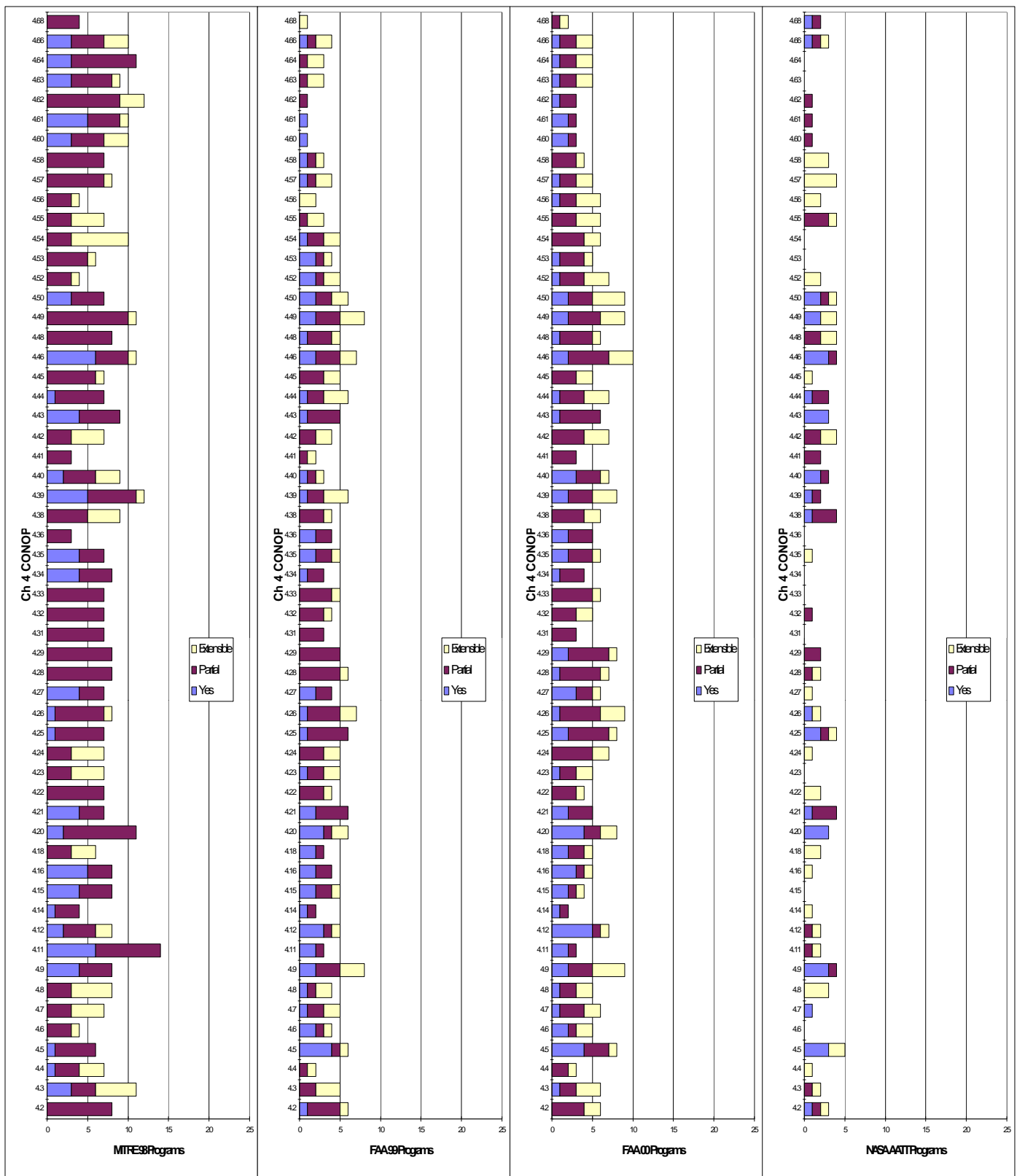
Figure 13: Chapter 4 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

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3.2.5   CHAPTER 5: EN ROUTE / CRUISE OPERATIONS & SERVICES

Figure 14 summarizes mappings of all programs to Chapter 5 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred.

Figure 15 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications

Figure 14: Programs per CONOP Chapter 5
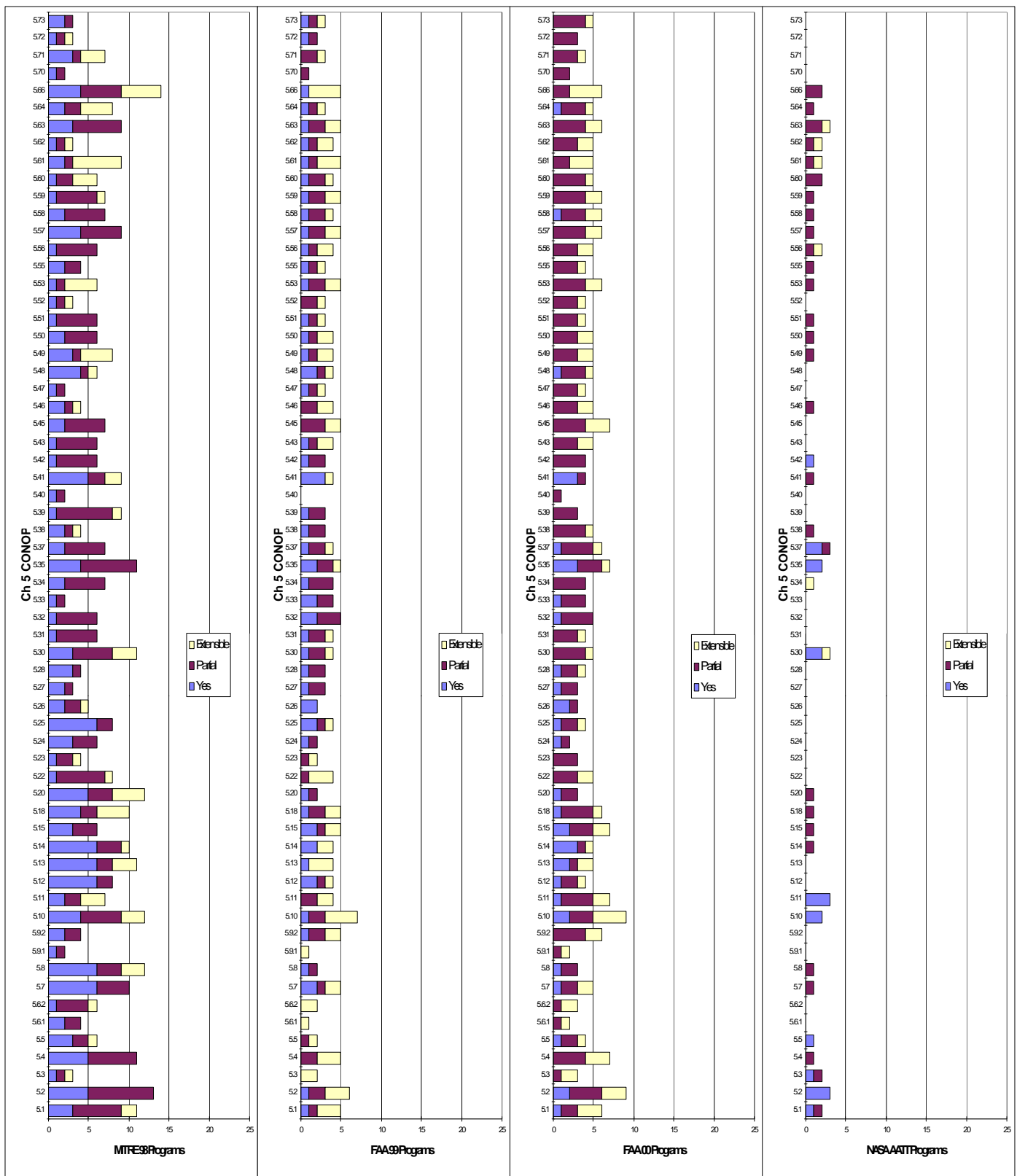
Figure 15: Chapter 5 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

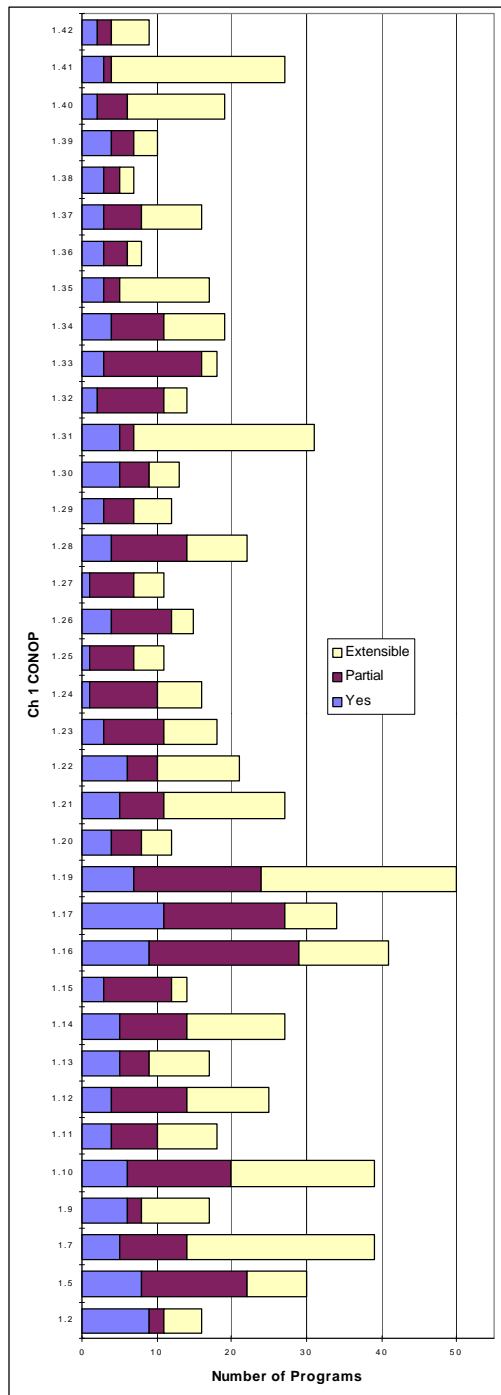## 3.2.6 CHAPTER 6: OCEANIC OPERATIONS & SERVICES
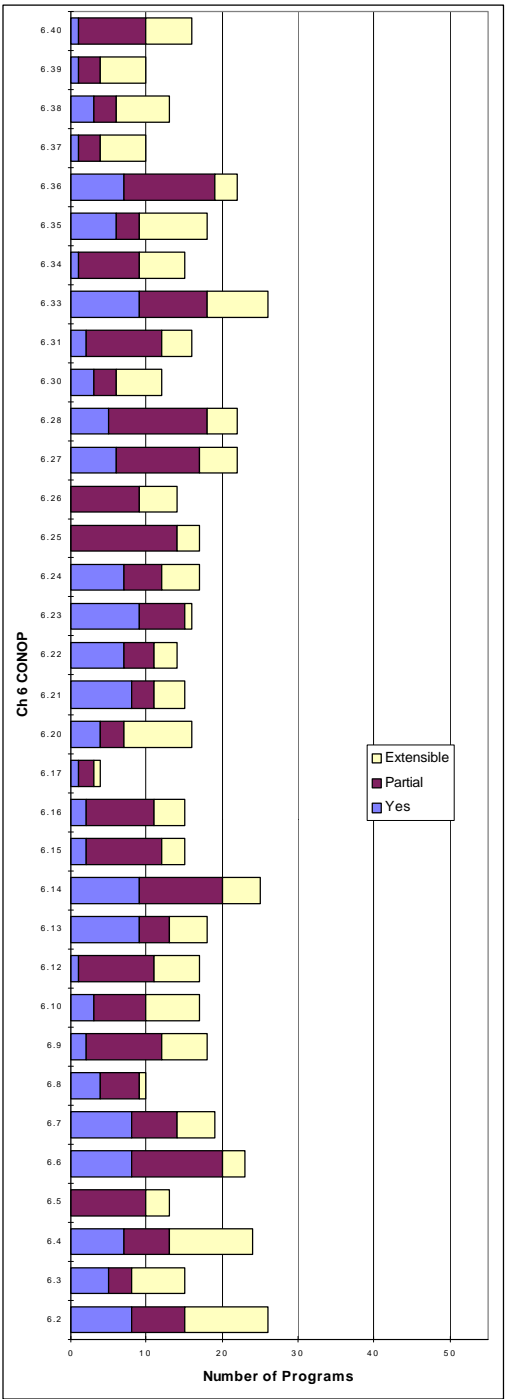
Figure 16: Programs per CONOP Chapter 6

Figure 16 summarizes mappings of all programs to Chapter 6 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred.

Figure 17 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

| Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications
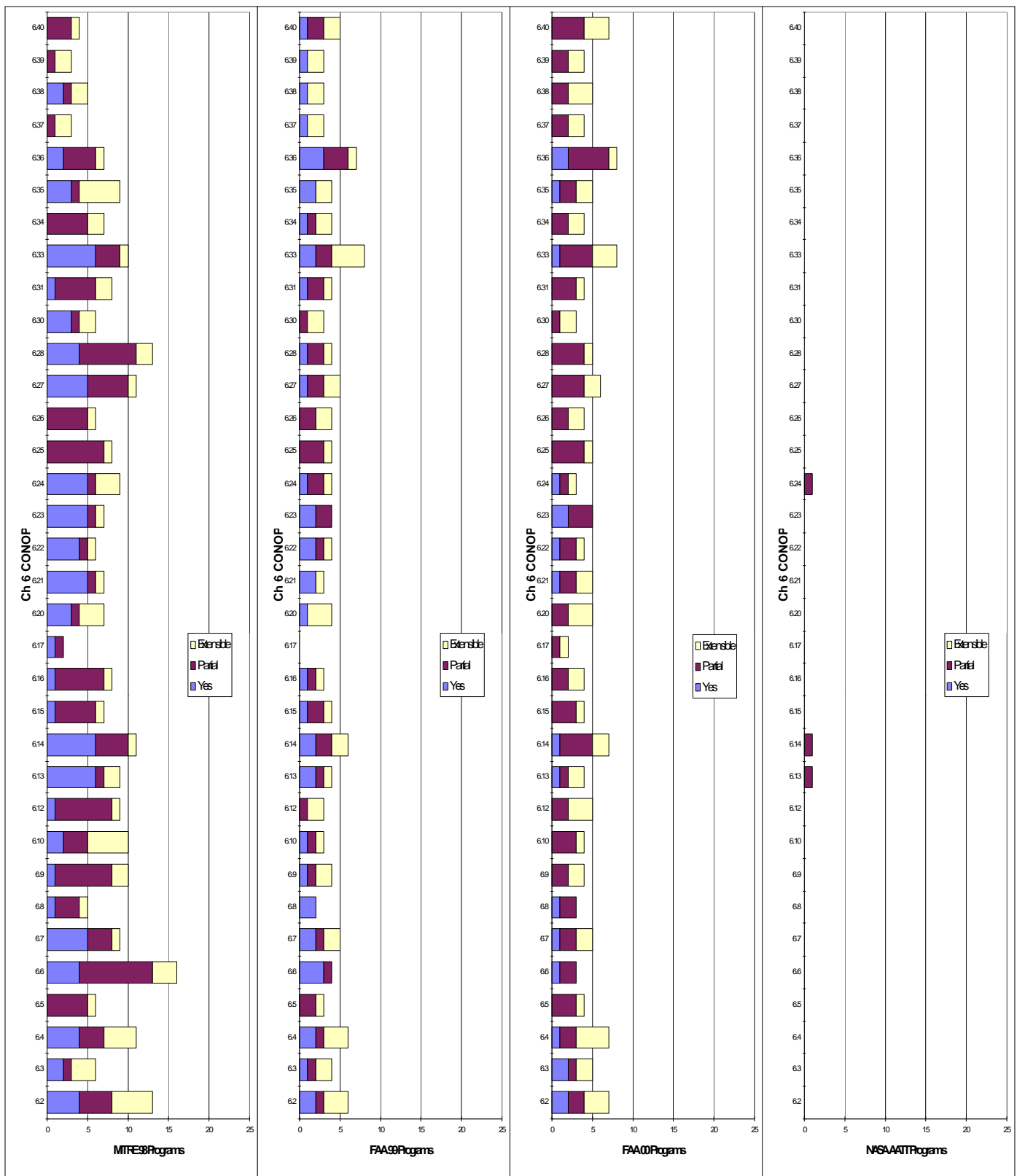
Figure 17: Chapter 6 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA
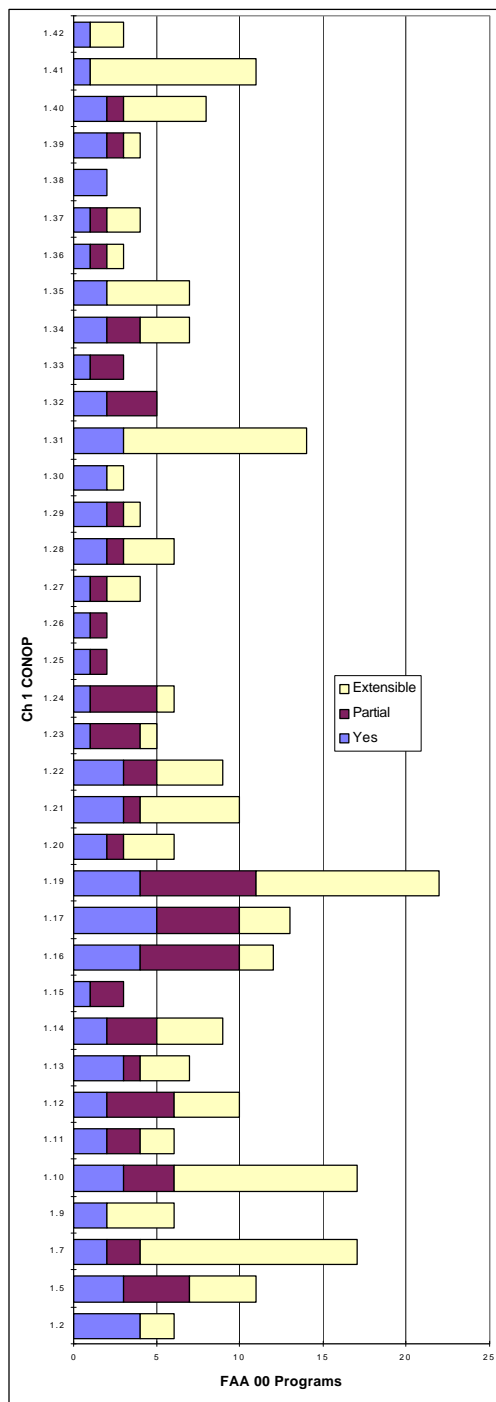
3.2.7 CHAPTER 7: NAS MANAGEMENT
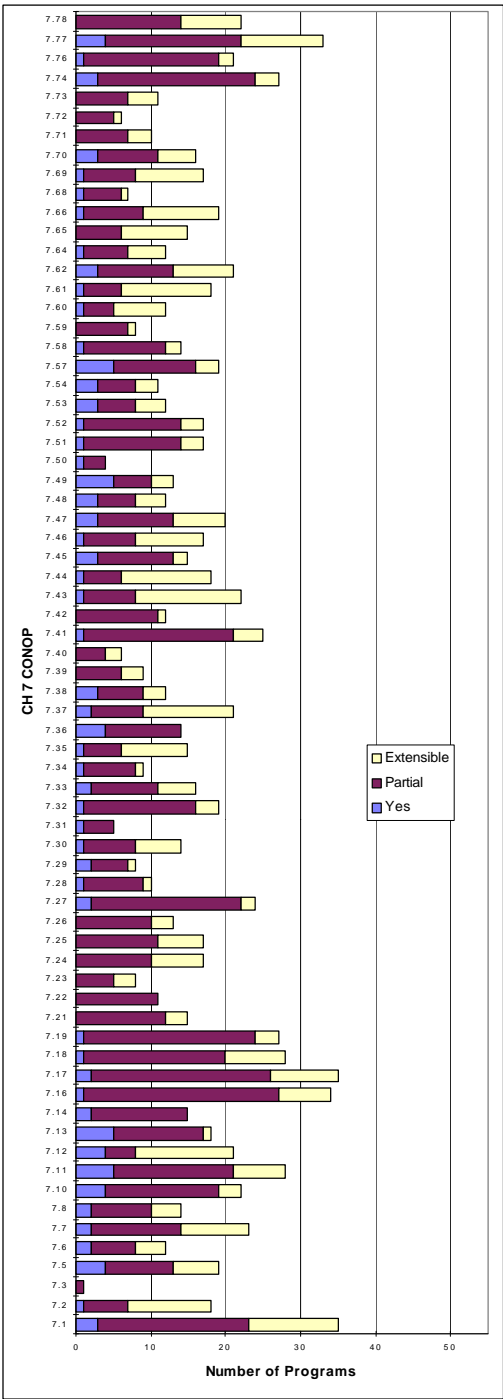
Figure 18: Programs per CONOP Chapter 7

Figure 18 summarizes mappings of all programs to Chapter 7 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred.

Figure 19 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications
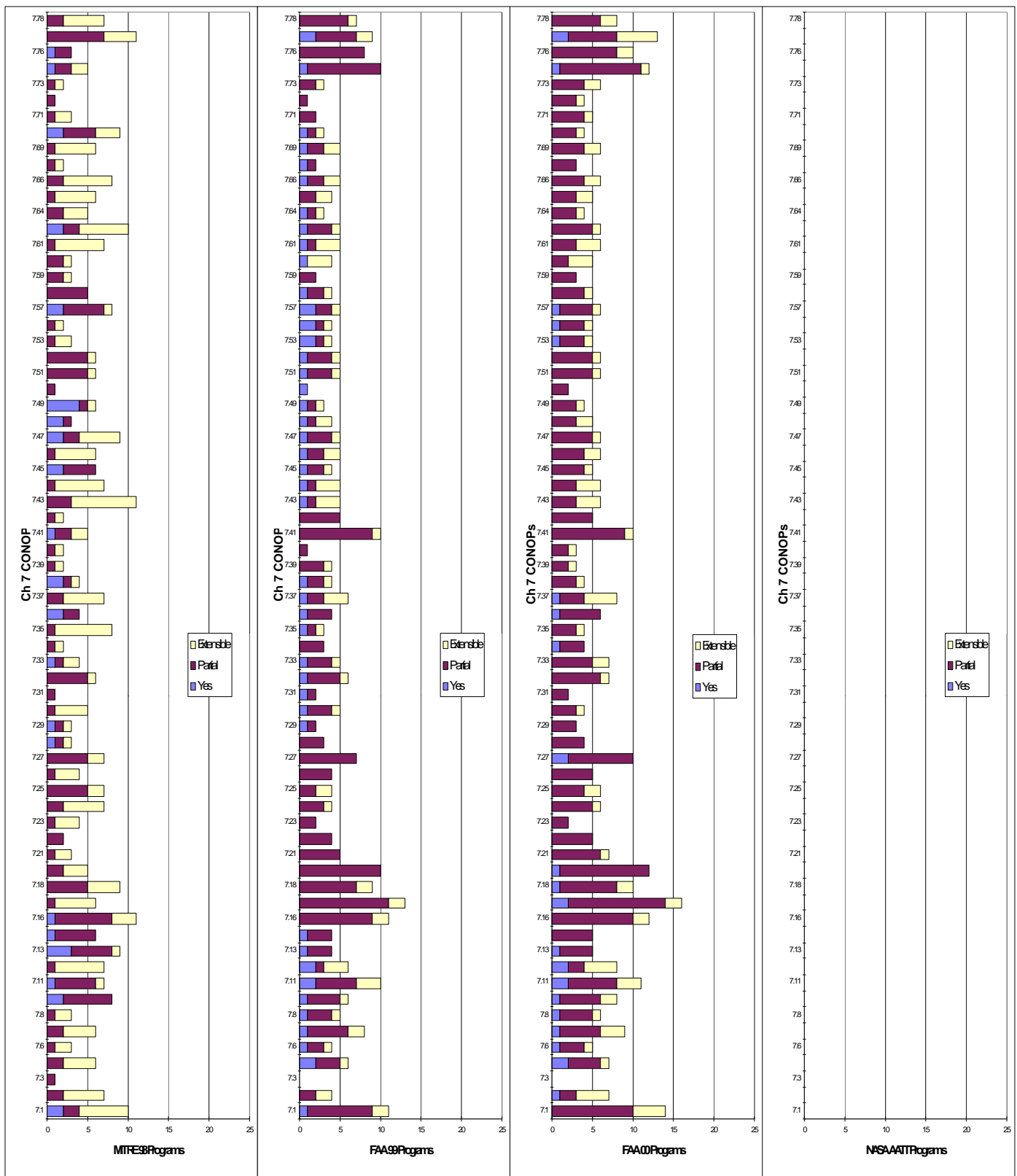
Figure 19: Chapter 7 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

3.2.8 CHAPTER 8: MANAGEMENT
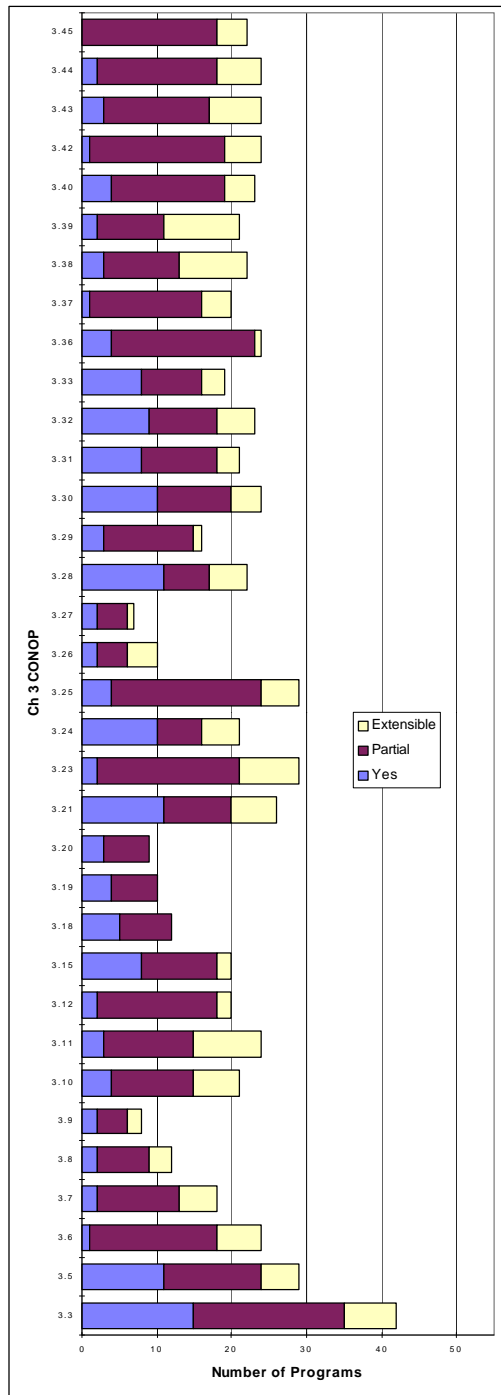

Figure 20 summarizes mappings of all programs to Chapter 8 of the ATS Concept of Operations Narrative. Each mapping of a CONOP to a program received a score of yes, partial, or extensible if a match occurred.

Figure 21 shows a further breakdown of the data per agency. The agencies represented are MITRE (FY 1998), the FAA (FY 1999 and 2000), and NASA AATT.

| Rating	Definition
Y	yes, the program addresses the CONOP
P	partial, the program supports the CONOP
E	extensible, the program could address the CONOP, with modifications

Figure 20: Programs per CONOP Chapter 8
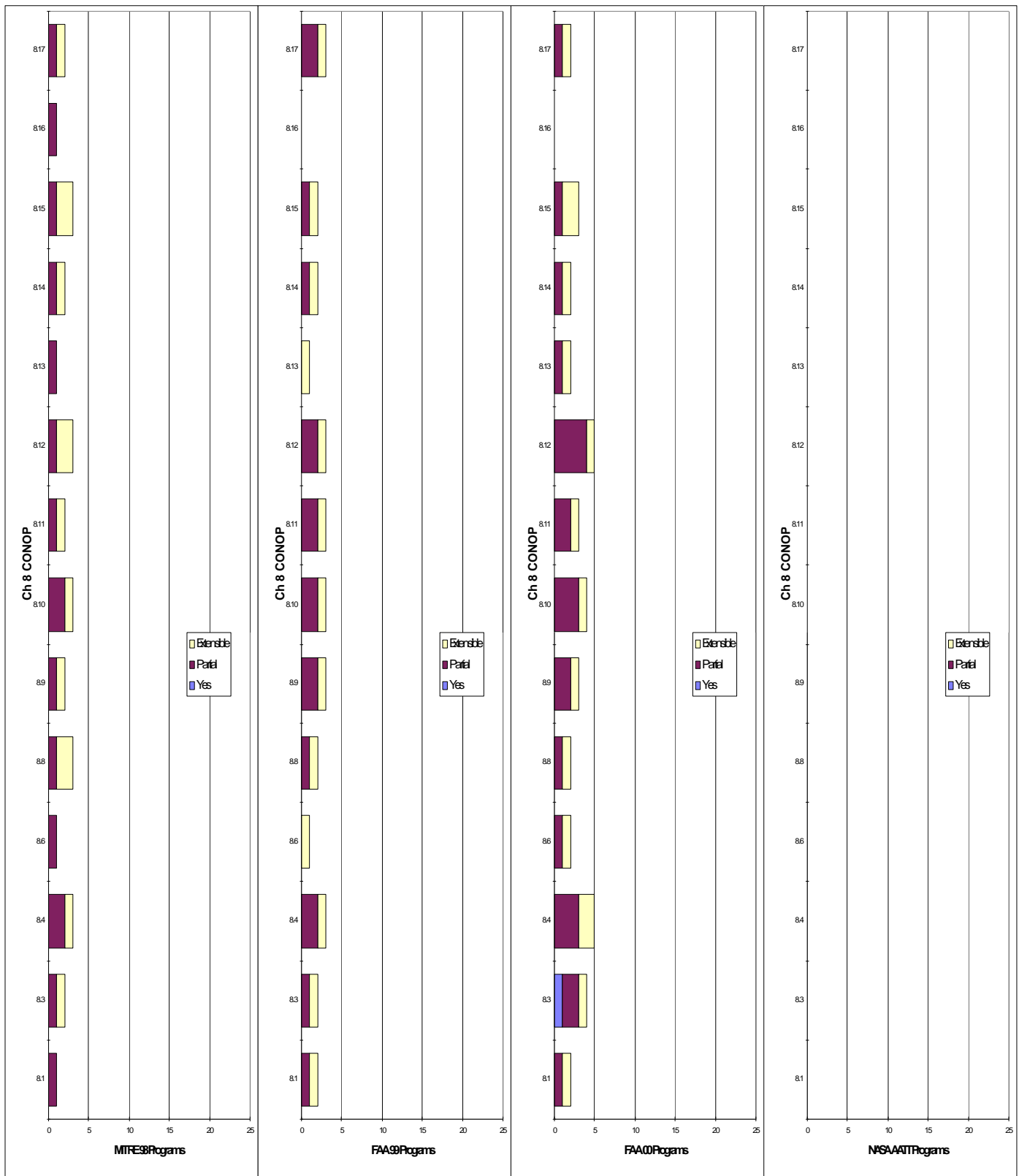
Figure 21: Chapter 8 Programs per CONOP MITRE 98, FAA 99, FAA 00, NASA

3.3 FAA PROGRAMS: FY 1999 AND FY 2000

The FAA programs that were a part of this study came form two sources, fiscal year 1999 and fiscal year 2000. Some programs from FY 1999 were continued into FY 2000, and are listed under both groups. For clarification, the following list represents which programs are only FY 1999 or FY 2000 programs, and which programs continue from FY 1999 into FY 2000. The bold faced programs are programs that were determined to directly, partially, or extensibly address one or more of the CONOPS.

On the far left of the list, are program file names belonging to FY 1999. On the far right of the list, are program file names belonging to FY 2000.

| **FAA 1999 Program File Name**		**FAA 2000 Program File Name**
99OPSC~2............... Operational Concept Development and Validation		
FAARPDTBD1 .... Next Generation Airport Lighting		
NAVRPD2.. Satellite Navigation		
NIMS_RPD......................... Infrastructure Requirements Analysis		
R&DMAPS...............................Improved NAS Map Generation		
SMARPD....................................RE&D on Surface Movement		
TA_EE_~1 ....Subsonic Jet Source Noise Reduction Research		
TFMRPD..TFM R&D		
119eds.doc....................................Electromagnetic Detection		
120eds.doc.................................Nuclear Explosives Detection		
116EDS DOC..........Trace Detection for Electronics, Baggage and Cargo		
115eds.doc................Trace Explosives Detection for Passenger Screening		
118eds.doc...................................X-Ray Explosives Detection		
117ct.doc ....Combined Technology for Explosives Detection		
ADLRPD7D....................................Aeronautical Data Link...rpdadl		
ADSBRPD ....ADS-B ....rpdads		
AND620 ....Traffic Alert and Collision Avoidance System (TCAS)....................rpdtca		
AWAFRPD........................Aviation Weather Analysis & Forecasting...........................rpdavw		
FAARPD132 .... Airport Planning & Design Technology rpd132		
FAARPD136 .... Improved Paving Materials rpd136		
FAARPD138 ....National Dynamic Airport Pavement Tests...........................rpd138		
FAARPD143 ....Non-Destructive Pavement Testing................................rpd143		
FAARPD144 .... Advanced Airport Pavement Designs................................rpd144		
FAARPD146 ....Improved Airport Lighting Signage and Markings......................rpd146		
FAARPD148 ....Improved Runway Traction rpd148		
FAARPD150 .... Airport Wildlife Hazard Abatement rpd150		
FAARPD152 .... Improved Rescue & Fire Fighting Equipment & Agents rpd152		
HF99RPD4.......................................ATS Human Factors..rpdhf		
MMRPD99............................ Aviation System Capacity Planning ....rpdasc		
PLANSRPD ....R,E&D Plans and Programs..planrpd		
PARTNRPD ....R&D Partnerships..partners		
RWYRPD .... Runway Incursion Reduction ....rpdrun		
SAFESOFT..........................Does Software Affect Flight Safety?................................rpdsof		
124ah.doc .... Explosive /Advanced Threat Vulnerability/Mitigation...................oorpdach		
130asti.doc................. Security of Civil Aviation Airports and Air Carriers ....oorpdast		
128HF.DOC ....Human Systems Integration ....oorpdhis		

3.4 RELATIONSHIP OF NASA AATT PRODUCTS TO FAA RPDS

Due to the fact that the NASA products reviewed in this study are very specific systems, it has been determined that they can not be viewed as duplicate efforts to the broad research areas described by the 1999 and 2000 FAA RPDs. This is not to suggest that they are unrelated but rather that they are specific products that are designed to satisfy a technology need in a given FAA research area.

Below, each of the NASA AATT Products is listed with its related FAA research areas.

Table 6: NASA ATT Product Relation to FAA Programs

NASA AATT PRODUCT	FAA 1999 File Name	FAA 2000 File Name	Title
Traffic Management Advisor (TMA)	TFMRPD		TFM R&D
		rpdtfm	**NAS Management**
	MMRPD99	rpdasc	**Aviation System Capacity Planning**
Passive Final Approach Spacing Tool (P-FAST)	TFMRPD~1.DOC		TFM R&D
	MMRPD99.DOC	rpdasc	**Aviation System Capacity Planning**
		rpdtfm	**NAS Management**
		rpdnav	**Navigation and Landing**
		rpdtea	**Terminal Automation Advanced Capabilities Integration**
Passive Surface Movement Advisor (SMA)	SMARPD		**R,E & D on Surface Movement**
	TFMRPD~1.DOC		**TFM R&D**
	FAARPD152	rpd152	**Improved Rescue & Fire Fighting Equipment & Agents**
	RWYRPD.DOC	rpdrun	**Runway Incursion Reduction**
		rpdtfm	**NAS Management**
		rpdtos	**Tower/Surface Automation**
		rpdtea	**Terminal Automation Advanced Capabilities Integration**
Conflict Prediction and Trial Planning (CPTP)	AND620.DOC	rpdtca	**Traffic Alert and Collision Avoidance System (TCAS)**
	MMRPD99.doc	rptdasc	**Aviation System Capacity Planning**
		rpdtea	**Terminal Automation Advanced Capabilities Integration**
En Route Descent Advisor (EDA)	AND620.doc	rpdtca	**Traffic Alert and Collision Avoidance System (TCAS)**
	MMRPD99.doc	rptdasc	**Aviation System Capacity Planning**
		rpdtea	**Terminal Automation Advanced Capabilities Integration**
Active Final Approach Spacing Tool (A-FAST)	TFMRPD.doc		**TFM R&D**
	MMRPD99.doc	rpdasc	**Aviation System Capacity Planning**
		rpdtfm	**NAS Management**
		rpdnav	**Navigation and Landing**
		rpdtea	**Terminal Automation Advanced Capabilities Integration**

Expedite Departure Path (EDP)	TFMRPD.doc		TFM R&D
	MMRPD99.doc	rpdasc	Aviation System Capacity Planning
		rpdtfm	NAS Management
		rpdtea	Terminal Automation Advanced Capabilities Integration
National Surface Advisory Tool (NSAT)	SMARPD		R,E & D on Surface Movement
	TFMRPD~1.DOC		TFM R&D
	RWYRPD.DOC	rpdrun	Runway Incursion Reduction
	FAARPD152	rpd152	Improved Rescue & Fire Fighting Equipment & Agents
		rpdtfm	NAS Management
		rpdtos	Tower/Surface Automation
		rpdtea	Terminal Automation Advanced Capabilities Integration
Collaborative Arrival Planning (CAP)	MMRPD99.doc	rpdase	Aviation System Capacity Planning
		rpdtea	Terminal Automation Advanced Capabilities Integration
Airborne Planner for Avoiding Traffic Hazards (APATH)	HF99RPD4.doc		ATS Human Factors
	TFMRPD.doc		TFM R&D
	AND620.doc	rpdtca	Traffic Alert and Collision Avoidance System (TCAS)
		9rpd20fd	Flight Deck Human Factors
		rpdtfm	NAS Management
		Rpdtea	Terminal Automation Advanced Capabilities Integration
		rpdavf	Avionics and Flight Systems Technology
Free Flight Satellite Communication Study	NAVRPD2.doc		Satellite Navigation

3.5 ANALYSIS RESULTS PER SUBDOMAIN OF CONOPS

The following data summarizes coverage of areas or "subdomains" within the chapters of the CONOPS. This will provide a further level of detail of the coverage of interest areas in the domains. A subdomain is defined as a service or operation function of a domain. The mappings of programs to CONOPS have been sorted by the subdomain in which the CONOPS belongs. The criteria for a program to appear in this overview is that it must have had at least a "yes" or "partial" judgement to any one of the individual requirements within that subdomain. Although several programs may appear in a subdomain, this should not be interpreted as duplicative activities or efforts. This breakout shows an overview of where some of the agencies' research programs being applied.

3.5.1 FLIGHT PLANNING

Subdomain 2.0- (**Flight Planning Operations & Services**)

Mitre 98	FAA 99	FAA 00	NASA
250KT Speed Restriction - Preferred Routes - FMS/GPS Routes - NIMS - Flight 2000: System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhancements	- Operational Concept Development And Validation - Aeronautical Data Link - ADS-B - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - TFM R&D	Free Flight Communication Study

Subdomain 2.1-(**Flight Planning Operations & Services**-Environment)

Mitre 98	FAA 99	FAA 00	NASA
250KT Speed Restriction - Preferred Routes - NIMS - Flight 2000: System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhancements - En Route Operational Concepts - En Route Architecture	- Operational Concept Development And Validation - Aeronautical Data Link - ADS-B - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - TFM R&D	- APATH - Free Flight Communication Study

Subdomain 2.2-(**Flight Planning Operations & Services**-Flight Planning Operations & Services)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • Preferred Routes • System Level Architecture	• Operational Concept Development And Validation • Aeronautical Data Link • Aviation Weather Analysis & Forecasting • TFM R&D • Improved NAS Map Generation	• NAS Design for Integration • Aeronautical Data Link • TFM R&D • Aviation Weather Analysis & Forecasting	• APATH • Free Flight Communication Study

Subdomain 2.3-(**Flight Planning Operations & Services**-Search & Rescue)

Mitre 98	FAA 99	FAA 00	NASA
• System Level Architecture	• Operational Concept Development And Validation • Aeronautical Data Link • TFM R&D	• NAS Design for Integration • Aeronautical Data Link	• Free Flight Communication Study

3.5.2   AIRPORT SURFACE OPERATIONS & SERVICES

Subdomain 3.0-(**Airport Surface Operations & Services**)

Mitre 98	FAA 99	FAA 00	NASA
• Runway Incursions • Terminal Area Evolution Strategy • System Level Architecture • ADS_B Implementation and Evolution Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhancements	• ADS-B • Aviation Weather Analysis & Forecasting • Airport Planning & Design Technology • Improved Paving Materials • Advanced Airport Pavement Designs • Improved Airport Lighting, Signage and Markings • Improved Rescue & Fire Fighting Equipment and Agents • Next Generation Airport Lighting • R&D on Surface Movement • Operational Concept Development And Validation • Aeronautical Data Link • TFM R&D	• NAS Design for Integration • Aeronautical Data Link • Aircraft Icing • Airport Planning & Design Technology • Improved Paving Materials • Advanced Airport Pavement Designs • Improved Airport Lighting, Signage and Markings • Improved Rescue & Fire Fighting Equipment and Agents • Next Generation Airport Lighting • ADS-B • Aviation Weather Forecasting & Analysis • Tower Surface Automation	• CAP • EDP • NSAT • SMA • Free Flight Communication Study

Subdomain 3.1-(**Airport Surface Operations & Services**-Environment)

Mitre 98	FAA 99	FAA 00	NASA
• Runway Incursions • TFM Operational Concept • Consensus-Based TFM Architecture • RVR and SUA Information • Mid-term Collaborative Routing Concept of Operations • NEXCOM Architecture • Terminal Area Evolution Strategy • Flight 2000: System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhancements	• Operational Concept Development And Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis & Forecasting • Improved Airport Lighting, Signage and Markings • Improved Rescue & Fire Fighting Equipment and Agents • Next Generation Airport Lighting • ATS Human Factors • Aviation System Capacity Planning • RE&D on Surface Movement • TFM R&D	• NAS Design for Integration • Improved Airport Lighting , Signage, and Markings • Improved Rescue & Fire Fighting Equipment and Agents • Next Generation Airport Lighting • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Aviation Weather Forecasting & Analysis • ATS Human Factors • Tower Surface Automation	• AFAST • CAP • EDP • Free Flight Communication Study • NSAT • SMA

Subdomain 3.2.1-(**Airport Surface Operations & Services**-Aviation Information)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • Runway Incursions • TFM Operational Concept • Consensus-Based TFM Architecture • Self Managed Arrival Resequencing Tool • NEXCOM Architecture • Terminal Area Evolution Strategy • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis and Forecasting • Airport Planning And Design Technology • Improved Paving Materials • Improved Airport Lighting, Signage, And Markings • Improved Runway Traction • Improved Rescue And Fire Fighting Equipment And Agents • Next Generation Airport Lighting • Runway Incursion Reduction • RE&D On Surface Movement • TFM R&D	• NAS Design for Integration • Airport Planning and Design Technology • Improved Paving Materials • Improved Airport Lighting, Signage, and Markings • Improved Runway Traction • Improved Rescue and Fire Fighting Equipment and Agents • Next Generation Airport Lighting, Signage and Markings • Aeronautical Data Link • ADS-B • Avionics and Flight System Technology • Aviation Weather Analysis & Forecasting • Runway Incursion Reduction • Tower Surface Automation	• CAP • EDP • Free Flight Communication STUDY • NSAT • SMA

Subdomain 3.2.2 (**Airport Surface Operations & Services**-Separation Assurance)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • Runway Incursions • Terminal Area Evolution Strategy • Terminal Area Operational Concepts • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Aeronautical Data Link • ADS-B • Airport Planning And Design Technology • Improved Airport Lighting, Signage, And Markings • Next Generation Airport Lighting • ATS Human Factors • Runway Incursion Reduction • RE&D On Surface Movement • TFM R&D	• NAS Design for Integration • Airport Planning and Design Technology • Improved Airport Lighting, Signage, and Markings • Next Generation Airport Lighting, Signage and Markings • Aeronautical Data Link • ADS-B • ATS Human Factors • Runway Incursion Reduction • Tower Surface Automation	• CAP • NSAT • SMA

Subdomain 3.2.3 (**Airport Surface Operations & Services** -Traffic Management Services)

Mitre 98	FAA 99	FAA 00	NASA
• Terminal Area Evolution Strategy • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• ADS-B • Aviation Weather Analysis and Forecasting • Improved Airport Lighting, Signage, And Markings • Next Generation Airport Lighting • ATS Human Factors • TFM R&D	• NAS Design for Integration • Improved Airport Lighting, Signage, and Markings • Next Generation Airport Lighting, Signage and Markings • ADS-B • Aviation Weather Analysis & Forecasting • ATS Human Factors • Tower Surface Automation	• NSAT • SMA

3.5.3 DEPARTURE AND ARRIVAL SERVICES

Subdomain 4.0 (**Departure and Arrival Services** - Departure and Arrival Services)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • Runway Incursions • Airspace Design • STARS Human Factors • Self Managed Arrival Resequencing Tool • Consensus-Based Navigation System Evolution Strategy • Future GPS • Terminal Area Needs Assessment • Terminal Area Evolution Strategy • Terminal Area Operational Concepts • FMS/GPS Routes • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Traffic Collision Avoidance System (TCAS) • Aviation Weather Analysis and Forecasting • Improved Airport Lighting, Signage, and Markings • Aviation System Capacity Planning • Improved NAS Map Generation • Runway Incursion Reduction • RE&D On Surface Movement • Subsonic Jet Source Noise Reduction Research • TFM R&D	• NAS Design for Integration • Improved Airport Lighting, Signage, and Markings • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Avionics and Flight System Technology • Aviation Weather Analysis & Forecasting • En Route/Oceanic DST Integration • Navigation and Landing • Runway Incursion Reduction • Traffic Collision Avoidance System (TCAS) • Terminal Automation Capabilities Integration • TFM R&D	• AFAST • APATH • CAP • EDP • Free Flight Communication Study • NSAT • P-FAST • TMA

Subdomain 4.1 (**Departure and Arrival Services** -Environment)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • STARS Human Factors • Self Managed Arrival Resequencing Tool • Consensus-Based Navigation System Evolution Strategy • Future GPS • NEXCOM Architecture • Terminal Area Needs Assessment • Terminal Area Evolution Strategy • Terminal Area Operational Concepts • FMS/GPS Routes • System Level Architecture • Certification of F2K Avionics • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis and Forecast • Improved Airport Lighting, Signage, And Markings • Runway Incursion Reduction • RE&D On Surface Movement • TFM R&D	• NAS Design for Integration • Improved Airport Lighting, Signage, and Markings • Aeronautical Data Link • ADS-B • Avionics and Flight System Technology • Aviation Weather Analysis & Forecasting • En Route/Oceanic DST Integration • Navigation and Landing • Runway Incursion Reduction • TFM R&D • Voice Switch Interface Research	• AFAST • Free Flight Communication Study • NSAT • P-FAST • TMA

Subdomain 4.2.1 (**Departure and Arrival Services-**Separation Assurance)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • Surveillance • STARS Human Factors • Self Managed Arrival Resequencing Tool • Collaborative Routing Coordination Tool • Consensus-Based Navigation System Evolution Strategy • WAAS Phase 1 Capability • Phase E Capability • LAAS Capability for CAT I/II/III Precision Approach • Terminal Area Needs Assessment • Terminal Area Evolution Strategy • Terminal Area Operational Concepts • FMS/GPS Routes • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Traffic Collision Avoidance System (TCAS) • Aviation Weather Analysis and Forecasting • Improved Airport Lighting, Signage, and Markings • ATS Human Factors • Aviation System Capacity Planning • Improved NAS Map Generation • Runway Incursion Reduction • Subsonic Jet Source Noise Reduction Research • TFM R&D	• NAS Design for Integration • Improved Airport Lighting, Signage, and Markings • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Avionics and Flight System Technology • Aviation Weather Analysis & Forecasting • En Route/Oceanic DST Integration • ATS Human Factors • Runway Incursion Reduction • Traffic Collision Avoidance System (TCAS) • Terminal Automation Capabilities Integration • TFM R&D	• AFAST • EDP • Free Flight Communication Study • NSAT • P-FAST • TMA

Subdomain 4.2.2 (**Departure and Arrival Services -**Traffic Management Services)

Mitre 98	FAA 99	FAA 00	NASA
- STARS Human Factors - TFM Operational Concept - Consensus-Based TFM Architecture - Terminal Area Needs Assessment - Terminal Area Evolution Strategy - Terminal Area Operational Concepts - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Aviation Weather Analysis and Forecasting - Improved Airport Lighting, Signage, And Markings - ATS Human Factors - Runway Incursion Reduction - RE&D On Surface Movement - TFM R&D	- NAS Design for Integration - Improved Airport Lighting, Signage, and Markings - Aeronautical Data Link - ADS-B - Aviation Weather Analysis & Forecasting - En Route/Oceanic DST Integration - ATS Human Factors - Runway Incursion Reduction - Terminal Automation Capabilities Integration - TFM R&D	- AFAST - EDP - P-FAST - TMA

Subdomain 4.2.3 (**Departure and Arrival Services -** Navigation / Landing Services)

Mitre 98	FAA 99	FAA 00	NASA
250KT Speed Restriction - STARS Human Factors - WAAS Phase 1 Capability - Phase E Capability - LAAS Capability for CAT I/II/III Precision Approach - Future GPS - Terminal Area Needs Assessment - Terminal Area Evolution Strategy - FMS/GPS Routes - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - ADS-B	- NAS Design for Integration - ADS-B - Navigation and Landing	Free Flight Communication Study

Subdomain 4.2.4 (**Departure and Arrival Services -** Airspace Management)

Mitre 98	FAA 99	FAA 00	NASA
• 250KT Speed Restriction • STARS Human Factors • Consensus-Based Navigation System Evolution Strategy • Terminal Area Needs Assessment • Terminal Area Evolution Strategy • FMS/GPS Routes • System Level Architecture • ADS-B Implementation and Evaluation Strategy	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B	• NAS Design for Integration • Aeronautical Data Link • ADS-B	• EDP

3.5.4 EN ROUTE/CRUISE OPERATIONS AND SERVICES

Subdomain 5.0 (**En Route/Cruise Operations and Services** - En Route / Cruise Operations and Services)

Mitre 98	FAA 99	FAA 00	NASA
- Miles-in-Trail Restrictions - Preferred Routes - Airspace Design - Surveillance - TFM Operational Concept - Consensus-Based TFM Architecture - Collaborative Routing Coordination Tool - Collaborative Routing Concept of Operations - URET - Initial Conflict Probe - Initial Conflict Probe - En Route Operational Concepts - En Route Architecture - Future GPS - NEXCOM Architecture - FMS/GPS Routes - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Aviation Weather Analysis and Forecasting - ATS Human Factors - Aviation System Capacity Planning	- NAS Design for Integration - Satellite Navigation - Aeronautical Data Link - ADS-B - Aviation System Capacity Planning - Aviation Weather Analysis & Forecasting - En Route/Oceanic DST Integration - ATS Human Factors - TFM R&D - Voice Switch Interface Research	- APATH - CPTP - EDA - Free Flight Communication Study

Subdomain 5.1 (**En Route/Cruise Operations and Services -** Environment)

Mitre 98	FAA 99	FAA 00	NASA
- Miles-in-Trail Restrictions - Preferred Routes - Surveillance - Self Managed Arrival Resequencing Tool - Collaborative Routing Coordination Tool - Collaborative Routing Concept of Operations - URET - Initial Conflict Probe - Initial Conflict Probe - En Route Operational Concepts - En Route Architecture - Consensus-Based Navigation System Evolution Strategy - Future GPS - NEXCOM Investment Decision - NEXCOM Architecture - FMS/GPS Routes - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Traffic Collision Avoidance System (TCAS) - Aviation Weather Analysis and Forecasting - ATS Human Factors - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - Aviation Weather Analysis & Forecasting - En Route/Oceanic DST Integration - ATS Human Factors - Navigation and Landing - Traffic Collision Avoidance System (TCAS) - TFM R&D	- APATH - CPTP - EDA - Free Flight Communication STUDY

Subdomain 5.2.1 (**En Route/Cruise Operations and Services -** Separation Assurance)

Mitre 98	FAA 99	FAA 00	NASA
- Miles-in-Trail Restrictions - Preferred Routes - Collaborative Routing Coordination Tool - URET - Initial Conflict Probe - En Route Operational Concepts - En Route Architecture - Future GPS - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Traffic Collision Avoidance System (TCAS) - Aviation Weather Analysis and Forecasting - ATS Human Factors - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - Aviation Weather Analysis & Forecasting - En Route/Oceanic DST Integration - ATS Human Factors - Navigation and Landing - Traffic Collision Avoidance System (TCAS) - TFM R&D	- APATH - CPTP - EDA - Free Flight Communication STUDY

Subdomain 5.2.2 (**En Route/Cruise Operations and Services -** Traffic Flow Management)

Mitre 98	FAA 99	FAA 00	NASA
- Preferred Routes - NIMS - TFM Operational Concept - Consensus-Based TFM Architecture - URET - Initial Conflict Probe - Initial Conflict Probe - En Route Operational Concepts - En Route Architecture - NEXCOM Architecture - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Aviation Weather Analysis and Forecasting - ATS Human Factors - Aviation System Capacity Planning - Improved NAS Map Generation - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - Aviation System Capacity Planning - Avionics and Flight System Technology - Aviation Weather Analysis & Forecasting - ATS Human Factors - TFM R&D	- APATH - CPTP - EDP - Free Flight Communication STUDY

Subdomain 5.2.3 (**En Route/Cruise Operations and Services -** Airspace Management)

Mitre 98	FAA 99	FAA 00	NASA
- TFM Operational Concept - Consensus-Based TFM Architecture - En Route Operational Concepts - En Route Architecture - System Level Architecture	- Operational Concept-Development and Validation - Aviation System Capacity Planning - TFM R&D	- NAS Design for Integration - Aviation System Capacity Planning - TFM R&D - Voice Switch Interface Research	

3.5.5   OCEANIC OPERATIONS AND SERVICES

Subdomain 6.0 (**Oceanic Operations and Services**)

Mitre 98	FAA 99	FAA 00	NASA
- Preferred Routes - Airspace Design - Surveillance - Self Managed Arrival Resequencing Tool - Collaborative Routing Concept of Operations - URET - Initial Conflict Probe - Initial Conflict Probe - Near-term Capabilities Definition - Oceanic Domain Concept Evolution for Mid Term - Oceanic Architecture Strategy to the Mid-term - Consensus-Based Navigation System Evolution Strategy - NEXCOM Investment Decision - NEXCOM Architecture - FMS/GPS Routes - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Traffic Collision Avoidance System (TCAS) - ATS Human Factors - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - Avionics and Flight System Technology - ATS Human Factors - Oceanic Separation Standards - Traffic Collision Avoidance System (TCAS)	

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Subdomain 6.1 (**Oceanic Operations and Services** - Environment)

Mitre 98	FAA 99	FAA 00	NASA
• Preferred Routes • Airspace Design • NAS Operational Concepts • Self Managed Arrival Resequencing Tool • En Route Architecture • Near-term Capabilities Definition • Oceanic Domain Concept Evolution for Mid Term • Oceanic Architecture Strategy to the Mid-term • Future GPS • NEXCOM Investment Decision • NEXCOM Architecture • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • ATS Human Factors • TFM R&D	• NAS Design for Integration • Satellite Navigation • Aeronautical Data Link • ADS-B • ATS Human Factors • TFM R&D	• Free Flight Communication STUDY

Subdomain 6.2.1 (**Oceanic Operations and Services** - Separation Assurance)

Mitre 98	FAA 99	FAA 00	NASA
- TFM Operational Concept - Consensus-Based TFM Architecture - Collaborative Routing Coordination Tool - URET - Initial Conflict Probe - En Route Operational Concepts - En Route Architecture - Oceanic Domain Concept Evolution for Mid Term - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Traffic Collision Avoidance System (TCAS) - ATS Human Factors - TFM R&D	- NAS Design for Integration - Satellite Navigation - Aeronautical Data Link - ADS-B - ATS Human Factors - Oceanic Separation Standards - Traffic Collision Avoidance System (TCAS) - TFM R&D	Free Flight Communication STUDY

Subdomain 6.2.2 (**Oceanic Operations and Services** - Traffic and Airspace Management)

Mitre 98	FAA 99	FAA 00	NASA
- Preferred Routes - Airspace Design - TFM Operational Concept - Consensus-Based TFM Architecture - Self Managed Arrival Resequencing Tool - Near-term Capabilities Definition - Oceanic Domain Concept Evolution for Mid Term - Oceanic Architecture Strategy to the Mid-term - NEXCOM Investment Decision - NEXCOM Architecture - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Requirements	- Operational Concept-Development and Validation - Aeronautical Data Link - ADS-B - Traffic Collision Avoidance System (TCAS) - Aviation Weather Analysis and Forecasting - ATS Human Factors - TFM R&D	- NAS Design for Integration - Aeronautical Data Link - ADS-B - Aviation Weather Analysis & Forecasting - ATS Human Factors - Traffic Collision Avoidance System (TCAS) - TFM R&D	

3.5.6 NAS MANAGEMENT

Subdomain 7.0 (**NAS Management**)

Mitre 98	FAA 99	FAA 00	NASA
• Airspace Design • En Route Architecture • System Level Architecture • ADS-B Implementation and Evaluation Strategy	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Improved Paving Materials • Improved Runway Traction • Improved Rescue and Fire Fighting Equipment and Agents • Improved Rescue and Fire Fighting Equipment and Agents • ATS Human Factors • Aviation System Capacity Planning • TFM R&D	• NAS Design for Integration • Improved Paving Materials • Improved Runway Traction • Airport Wildlife Hazard Abatement • Improved Rescue and Fire Fighting Equipment and Agents • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • ATS Human Factors • TFM R&D	

Subdomain 7.1.1 (**NAS Management** - Traffic Flow Management)

Mitre 98	FAA 99	FAA 00	NASA
• NIMS • Airspace Design • STARS Human Factors • TFM Operational Concept • Consensus-Based TFM Architecture • Collaborative Routing Concept of Operations • En Route Operational Concepts • En Route Architecture • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Requirements	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis and Forecasting • Improved Paving Materials • Improved Airport Lighting, Signage, And Markings • Improved Rescue And Fire Fighting Equipment And Agents • Improved Rescue And Fire Fighting Equipment And Agents • Next Generation Airport Lighting • ATS Human Factors • Aviation System Capacity Planning • Infrastructure Requirements Analysis • TFM R&D	• NAS Design for Integration • Improved Paving Materials • Improved Airport Lighting, Signage, and Markings • Airport Wildlife Hazard Abatement • Improved Rescue and Fire Fighting Equipment and Agents • Next Generation Airport Lighting, Signage and Markings • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Aviation Weather Analysis & Forecasting • ATS Human Factors • TFM R&D	

Subdomain 7.1.2 (**NAS Management** - Infrastructure Management)

Mitre 98	FAA 99	FAA 00	NASA
• NIMS • Airspace Design • NAS Architecture • NAS Operational Concepts • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept- Development and Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis and Forecasting • Airport Planning And Design Technology • Improved Paving Materials • Non-Destructive Pavement Testing • Advanced Airport Pavement Design • Improved Runway Traction • Improved Rescue And Fire Fighting Equipment And Agents • Improved Rescue And Fire Fighting Equipment And Agents • Next Generation Airport Lighting • ATS Human Factors • Aviation System Capacity Planning • Infrastructure Requirements Analysis • R&D Partnerships • RE&D Plans and Programs	• NAS Design for Integration • Airport Planning and Design Technology • Improved Pavement Materials • Non-Destructive Pavement Testing • Advanced Airport Pavement Design • Improved Runway Traction • Airport Wildlife Hazard Abatement • Improved Rescue and Fire Fighting Equipment and Agents • Next Generation Airport Lighting, Signage and Markings • R&D Partnerships • • RE&D Plans and Programs • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Aviation Weather Analysis & Forecasting • ATS Human Factors • Terminal Automation Capabilities Integration • TFM R&D	

Subdomain 7.2.1 (**NAS Management** - Traffic Flow Management)

Mitre 98	FAA 99	FAA 00	NASA
• NIMS • STARS Human Factors • TFM Operational Concept • Consensus-Based TFM Architecture • Collaborative Routing Concept of Operations • En Route Architecture • System Level Architecture • ADS-B Implementation and Evaluation Strategy • ADS-B Procedures • TCAS Enhancements • Surveillance Enhance	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis and Forecasting • Airport Planning And Design Technology • ATS Human Factors • Aviation System Capacity Planning • Infrastructure Requirements Analysis • TFM R&D	• NAS Design for Integration • Airport Planning and Design Technology • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Aviation Weather Analysis & Forecasting • ATS Human Factors • Terminal Automation Capabilities Integration • TFM R&D	

Subdomain 7.2.2 (**NAS Management** - Infrastructure)

Mitre 98	FAA 99	FAA 00	NASA
• NIMS • System Research • TFM Operational Concept • Consensus-Based TFM Architecture • System Level Architecture	• Operational Concept-Development and Validation • Airport Planning And Design Technology • Non-Destructive Pavement Testing • Advanced Airport Pavement Design • Improved Runway Traction • Improved Rescue And Fire Fighting Equipment And Agents • Improved Rescue And Fire Fighting Equipment And Agents • ATS Human Factors • Aviation System Capacity Planning • Infrastructure Requirements Analysis • RE&D Plans And Programs • TFM R&D	• NAS Design for Integration • Airport Planning and Design Technology • Non-Destructive Pavement Testing • Advanced Airport Pavement Design • Improved Runway Traction • Airport Wildlife Hazard Abatement • Improved Rescue and Fire Fighting Equipment and Agents • RE&D PLANS AND PROGRAMS • Aviation System Capacity Planning • ATS Human Factors	

Subdomain 7.3.1 (**NAS Management** - Traffic Flow Management)

Mitre 98	FAA 99	FAA 00	NASA
- NIMS - Airspace Design - Surveillance - System Research - STARS Human Factors - TFM Operational Concept - Consensus-Based TFM Architecture - En Route Operational Concepts - En Route Architecture - Terminal Area Needs Assessment - Terminal Area Evolution Strategy - System Level Architecture - ADS-B Implementation and Evaluation Strategy - ADS-B Procedures - TCAS Enhancements - Surveillance Enhance	- Operational Concept-Development and Validation - ADS-B - Traffic Collision Avoidance System (TCAS) - Aviation Weather Analysis and Forecasting - Airport Planning And Design Technology - Advanced Airport Pavement Design - ATS Human Factors - Aviation System Capacity Planning - TFM R&D	- NAS Design for Integration - Airport Planning and Design Technology - Advanced Airport Pavement Design - ADS-B - Aviation System Capacity Planning - Aviation Weather Analysis & Forecasting - ATS Human Factors - Traffic Collision Avoidance System (TCAS) - TFM R&D	

Subdomain 7.3.2 (**NAS Management** - Infrastructure)

Mitre 98	FAA 99	FAA 00	NASA
• NIMS • Surveillance • STARS Human Factors • NEXCOM Investment Decision • NEXCOM Architecture • System Level Architecture • ADS-B Implementation and Evaluation Strategy	• Operational Concept-Development and Validation • Aeronautical Data Link • ADS-B • Aviation Weather Analysis and Forecasting • Airport Planning And Design Technology • Improved Paving Materials • Non-Destructive Pavement Testing • Advanced Airport Pavement Design • Improved Airport Lighting, Signage, And Markings • Improved Runway Traction • Improved Rescue And Fire Fighting Equipment And Agents • Improved Rescue And Fire Fighting Equipment And Agents • Next Generation Airport Lighting • Aviation System Capacity Planning • Infrastructure Requirements Analysis • RE&D Plans And Programs	• NAS Design for Integration • Airport Planning and Design Technology • Improved Paving Materials • Non-Destructive Pavement Testing • Advanced Airport Pavement Design • Improved Airport Lighting, Signage, and Markings • Improved Runway Traction • Airport Wildlife Hazard Abatement • Improved Rescue and Fire Fighting Equipment and Agents • Next Generation Airport Lighting, Signage and Markings • RE&D PLANS AND PROGRAMS • Aeronautical Data Link • ADS-B • Aviation System Capacity Planning • Aviation Weather Analysis & Forecasting • Terminal Automation Capabilities Integration • Voice Switch Interface Research	

3.5.7 MANAGEMENT

Subdomain 8.0 (**Management**)

Mitre 98	FAA 99	FAA 00	NASA
• NIMS • STARS Human Factors • System Level Architecture	• Operational Concept-Development and Validation • ATS Human Factors • Infrastructure Requirements Analysis	• NAS Design for Integration • Aviation Maintenance Human Factors • ATS Human Factors • Technical Lab	

Subdomain 8.1 (**Management** - Environment)

Mitre 98	FAA 99	FAA 00	NASA
• System Level Architecture	• Operational Concept-Development and Validation • Infrastructure Requirements Analysis • RE&D Plans And Programs	• NAS Design for Integration • Aviation Maintenance Human Factors • RE&D Plans And Programs • Aviation System Capacity Planning • Technical Lab	

Subdomain 8.2 (**Management** - Management Operations and Services)

Mitre 98	FAA 99	FAA 00	NASA
• System Level Architecture	• Operational Concept-Development and Validation • Infrastructure Requirements Analysis • TFM R&D	• NAS Design for Integration	

4   CONCLUSIONS

The mapping of research and development programs to the Level I CONOPS creates a picture of how ongoing work relates to the vision of the future of air traffic described in the "Air Traffic Services Concept of Operations for the National Airspace System in 2005: Narrative." While this report has documented these relationships it has also brought to light some additional aspects of the nature of the programs and the mapping process.

System Integration "Capstone" Programs Are Needed: It is important to note that there are few CONOPS that are fully addressed by one individual program. In most cases, the CONOP is covered by a group of programs that potentially satisfy the complete functional needs of that CONOP. In other words, there are several program to CONOP matches with only a partial judgement assigned to them, that together form one integrated solution. There is the need for "capstone" programs to be developed that will combine the capabilities of all the programs relative to that CONOP to form one combined solution. An example of this need is the following:

CONOP 4.32 from Departure and Arrival Services reads. "The service provider maintains separation between controlled aircraft and active SUAs, and between controlled aircraft and terrain /obstructions".

The means, or technology solutions that makes this CONOP possible, are derived by integrating the capabilities of several programs and tools that matched in only a "partial" capacity. The following are the programs that mapped to this CONOP in both a potential and extensible judgement.

Table 7: Example in Support of Capstone Projects

File Name	Program Name	Rating
Rpdtea	**FAA FY00-** Terminal Automation Advanced Capabilities Integration	P
Rpdndi	**FAA FY00-**NAS Design for Integration	P
Adsbrpd	**FAA FY99 & FY00-**Automatic Dependent Surveillance (ADS-B)	P
And620	**FAA FY99 & FY00-**Traffic Alert and Collision Avoidance System (TCAS)	E
R&Dmaps2	**FAA FY99-**Improved NAS Map Generation	P
Tfmrpd~1	**FAA FY99-**Traffic Flow Management R&D	P
Mitre 98.9.1	**MITRE FY98-** ADS-B Procedures	P
Mitre 98.8.4	**MITRE FY98-** Flight 2000: ADS-B Implementation and Evaluation Strategy	P
Mitre 98.9.3	**MITRE FY98-** Surveillance Requirements	P
Mitre 98.9.2	**MITRE FY98-** TCAS Enhancements	P
Mitre 98.7.2	**MITRE FY98-** Terminal Area Evolution Strategy	P
Mitre 98.15.1	**MITRE FY98-**STARS Human Factors	P
AFAST	**NASA FY98-** Active Final Approach Spacing Tool	P

FAA vs. NASA: In the analysis of FAA vs. NASA, no true overlaps occurred because the program goals of the agencies differ. While the FAA Research Program Descriptions create definitions of procedures, implementation plans, or technology integration, the NASA programs create tools that are technology solutions.

Budget Impacts: Although this study has created mappings of programs that satisfy Level I CONOPS, whether or not those programs will be completed has not been evaluated. Because of this stipulation, budget will greatly impact future programs and the fulfillment of the Level I CONOPS.

Categorization is an Effective Tool for Mapping: In the mapping process outlined in this study, 129 programs were mapped against 390 Level I CONOPS. Without categorization, each program would have needed to be compared to each Level I CONOPS. By categorizing the programs and Level I CONOPS, and only comparing category matches, the mapping process was streamlined.

In conclusion, the mappings from this study have yielded a number of useful results. Conglomerated into Narrative Chapters, the mappings show the relative concentration of research in the different domains (Figure 5). Broken out into mappings of programs to individual CONOPS, they reveal gaps or overlaps of CONOPS coverage by programs. To resolve these gaps and overlaps, requires an evolution of research being done or of the vision of the NAS in 2005. If a gap exists in the mappings because a need is being addressed poorly, the research can evolve to fit the need. Similarly, if a gap or overlap exists in the mappings because a need is being stated poorly, the need can evolve to clarify its meaning. The mappings identify potential areas that need resolution, and the method is an evolution of the research and vision towards the NAS in 2005.

WORKS CITED

1. Department of Transportation, Federal Aviation Administration, "*Air Traffic Services Concept of Operations for the National Airspace System in 2005: Narrative*", Washington, D.C., September 30, 1997.

2. Department of Transportation, Federal Aviation Administration, *"1997 FAA Aviation System Capital Investment Plan "*, Washington, D.C., 1997.

3. Department of Transportation, Federal Aviation Administration, "*Air Traffic Services Concept of Operations for the National Airspace System in 2005: Operational Tasks and Scenarios"*, Washington, D.C., February 5, 1998.

4. Aviation Week and Space Technology, January 13, 1997.

APPENDIX A. ACRONYMS AND ABBREVIATIONS

This is an Air Traffic Control acronym list augmented with some acronyms used in this report.

A/C	Aircraft
ABPE	Automated Barometric Pressure Entry
ACARS	Aircraft Communications Addressing and Reporting System
ACE	Aviation Capacity Enhancements
ADAS	AWOS Data Acquisition System
ADDS	Aviation Digital Data Service
ADF	Automatic Direction Finder
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance Broadcast
AERA	Automated En route Air Traffic Control
AF	Airway Facilities
AFSS	Aeronautical Flight Services Station
AFTN	Aeronautical Fixed Telecommunications Network
AGATE	Advanced General Aviation Transportation Equipment
AGFS	Aviation General Forecast System
AIP	Airport Improvement Program
AIRMET	Airman's Meteorological Information
ALDARS	ASOS Lighting Detection and Reporting System
ALSF	Approach Lighting System with Sequenced Flashing Lights
AMASS	Approach Movement Area Safety System
AMS	Acquisition Management System
AMSS	Aeronautical Mobile Satellite Service
ANICS	Alaska NAS Interfacility Communications System
ANSI	American National Standards Institute
AOAS	Advanced Oceanic Automation System
AOC	Airline Operations Center
APP	Application Portability Profile
ARINC	Aeronautical Radio, Incorporated
ARP	Airport Organization
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASD	Aircraft Situation Display
ASDI	Aircraft Situation Display to Industry
ASDE	Airport Surface Detection Equipment
ASOS	Automated Surface Observing System
ASR	Airport Surveillance Radar
ASR-WSP	Airport Surveillance Radar-Weather System Processor
ASRP	Aviation Safety Research Program
ASTERIX	All Purpose Structural Eurocontrol Radar Information Exchange
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
ATCSCC	Air Traffic Control System Command Center
ATCT	Airport Traffic Control Tower
ATIS	Airport Traffic Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
AVR	Regulation And Certification Organization
AWC	Aviation Weather Center
AWOS	Automated Weather Observing System
AWP	Aviation Weather Processor
AWR	Aviation Weather Requirement
B	Billion
BRI	Basic Rate Interface

BUEC	Backup Emergency Communications
CARF	Central Altitude Reservation Function
CASA	Controller Automation Spacing Aid
CAT	Category
CAT I	Category I Approaches
CAT II	Category II Approaches
CAT III	Category III Approaches
CBA	Cost-Benefit Analysis
CDM	Collaborative Decision Making
CDTI	Cockpit Display Of Traffic Information
CENRAP	Center Radar ARTS Presentation
CFR	Code Of Federal Regulation
CFWARP	Central Flow WARP
CHI	Computer Human Interface
CNS	Communication, Navigation, Surveillance
CNS/ATM	Communication, Navigation, Surveillance/Air Traffic Management
CONOPS	Concept Of Operations, also Level I Concept of Operations
CONUS	Continental United States Cost Performance System
COPS	Cost Performance System
COTS	Commercial Off-The-Shelf
CP	Conflict Probe
CPC	Controller-Pilot Communications
CPDLC	Controller To Pilot Data Link Communications
CRDA	CONOP and Requirement Tracking System (SRC generated acronym)
CRTS	Converging Runway Display Aid
CTA	Control By Time Of Arrival
CTAS	Center TRACON (Terminal Radar Approach) Automation System
CWSU	Center Weather Surface Unit
D-ATIS	Digital Automatic Terminal Information Services
DARC	Direct Access Radar Channel
DASI	Digital Altimeter Setting Indicator
DBRITE	Digital Bright Radar Indicator Tower-Equipment
DDTC	Data Delivery Of Taxi Clearance
DLAP	Data Link Applications Processor
DME	Distance Measuring Equipment
DOD	Department Of Defense
DOTS	Dynamic Ocean Tracking System
DSR	Display System Replacement
DSS	Decision Support System
DUATS	Direct User Access Terminal System
E-IDS	Enhanced Next Generation Information Display System
EARTS	En Route Automated Radar Tracking System
EFIS	Electronic Flight Information System
EMC	Environmental Modeling Center
EOSL	End Of Service Life
EERDI	En Route Domain Infrastructure
ETMS	Enhanced Traffic Management System
ETN	Electronic Tandem Network
ETVS	Enhanced Terminal Voice Switch
EVCS	Emergency Voice Communications
F&E	Facilities An Equipment
FAA	Federal Aviation Administration
FAATSAT	FAA Telecommunications Satellite
FANS	Future Air Navigation System
FAR	Federal Aviation Regulation
FBWTG	FAA Bulk Weather Telecommunications Gateway

FAST	Final Approach Spacing Tool
FDIO	Flight Data Input Output
FDM	Flight Data Management
FDP	Flight Data Processor
FFTS	Full Fidelity Training Simulator
FIR	Flight Information Region
FIS	Flight Information Service
FL	Flight Level
FMA	Final Monitor Aid
FMS	Flight Management System
FOC	Full Operating Capability
FPS	Fixed Position Surveillance
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSL	Forecast Systems Laboratory
FSS	Flight Service Station
FTS	Federal Telecommunications System
FY	Fiscal Year
GA	General Aviation
GDP	Ground Delay Program
GICB	Ground-Initiated Comm-B
GIS	Geographic Information System
GLONASS	Global Navigation Satellite System
GPS	Global Positioning System
GPS	Global Positioning Satellite
GUI	Graphic User Interface
GWDS	Graphic Weather Display System
HARS	High Altitude Route System
HCS	Host Computer System
HF	High Frequency
HFDL	High Frequency Data Link
HID	Host Interface Device
HID/NAS LAN	Host Interface Device/ NAS Local Area Network
HQ	Headquarters
HIS	Human-System Integration
HVAC	Heating, Ventilation, And Air Conditioning
HW	Hardware
ICAO	International Civil Aviation Organization
ICP	Initial Conflict Probe
IFR	Instrument Flight Rules
ILS	Instrument Landing
IMC	Instrument Meteorological Conditions
INFOSEC	Information Security
INS	Inertial Navigation Systems
IOC	Initial Operating Capability
IPT	Integrated Product Team
ITWS	Integrated Terminal Weather System
JRC	Joint Resources Council
KBPS	Kilo Bytes Per Second
KHZ	Kilo Hertz
LAAS	Local Area Augmentation System
LAN	Local Area Network
LCCE	Life Cycle Cost Estimate
LDRCL	Low-Density Radio Communications Link
LEOS	Level 1 Concept of Operations or CONOP
Level I	Low Earth-Orbiting Satellite

CONOP
LINCS   Leased Interfacility National Airspace Communication System
LIS   Local Information System
LLWAS   Low-level Wind Shear Alert System
LORAN-C   Long Range Navigation-C System
LRR   Long Range Radar
M   Million
M1FC   Mode 1 Full Capacity
MALSR   Medium Intensity Approach Lighting System With Runway Alignment Indicator Lights
MASPS   Minimum Aviation System Performance Standards
MCI   Mode-C Intruder
MDCRS   Meteorological Data Collection And Reporting System
MEOS   Medium Earth-Orbiting Satellite
MET.   Meteorological
MHZ   Mega Hertz
MIGFA   Machine Intelligent Gust Front Algorithm
MIT   Miles In Trail
MIT/LL   Massachusetts Institute Of Technology/Lincoln Laboratory
MLS   Microwave Landing System
MMAC   Mike Monroney Aeronautical Center
MODE-S   Mode S
MOPS   Minimum Operating Standard
MPAR   Multi-Purpose Airport Radar
MSAW   Minimum Safe Altitude Warning
NADIN   National Airspace Data Interchange Network
NAS RD   NAS Requirements Document
NASA   National Aeronautics And Space Administration
NAVAID   Navigational Aid
NCEP   National Center For Environmental Protection
NCAR   National Center For Atmospheric Research
NDB   Non Directional Beacon
NESDIS   National Environmental Satellite, Data, And Information Service
NEXCOM   Next Generation Air-To-Ground Communications System
NEXRAD   Next Generation Radar
NIC   Network Interface Cards
NIMS   NAS Infrastructure Management System
NIS   NAS-Wide Information Service
NIST   National Institute Of Standards And Technology
NM   Nautical Mile
NOAA   National Oceanic And Atmospheric Administration
NOTAM   Notice To Airmen
NRC   National Research Council
NSF   National Science Foundation
NSSL   National Server Storms Laboratory
NWS   National Weather Service
NWSTG   NWS Telecommunications Gateway
O&M   Operations And Maintenance
OAG   Official Airline Guide
OASIS   Operational And Supportability Implementation System
OCS   Offshore Computer System
OMB   Office Of Management And Budget
ORD   Operational Readiness Demonstration
P^3I Per-Planned Product Improvement
PAMRI   Peripheral Adapter Module Replacement Item
PABX   Public Automation Branch Exchange
PAPI   Precision Approach Path Indicator
PBC   Private Branch Exchange
PDC   Pre-Departure Clearance

PDT	Product Development Team
PFC	Passenger Facility Charge
PIDP	Programmable Indicator Processor
PIREP	Pilot Report
PPS	Precise Positioning Service
PPSS	Portable Performance Support System
PRM	Parallel Runway Monitor
PSN	Packet Switching Network
PVD	Plan View Display
RCE	Radio Central Equipment
RCL	Radio Communication Link
RD	Requirements Document
RDA	Radar Data Acquisition
R,E,&D	Research, Engineering And Development
RMMS	Remote Maintenance Monitoring System
RNAV	Area Navigation
RPG	Radar Product Generator
RTA	Required Time Of Arrival
RTCA	RTCA, Incorporated
RVR	Runway Visual Range
SAIDS	Systems Atlanta Information Display System
SAMS	Special Use Airspace Management System
SAR	Search And Rescue
SCAT-1	Special Use Category I System
SDP	Surveillance Data Processor
SEAMS	Safety, Environment Assessment Management System
SFO	San Francisco International Airport
SI	Selective Interrogation
SIGMET	Significant Meteorological Information
SLIM	Software Life Cycle Model
SMA	Surface Movement Advisor
SMD	Surface Movement Detector
SME	Subject Matter Expert
SRC	System Resources Corporation, Inc.
SSR	Secondary Surveillance Radar
STARS	Standard Terminal Automation Replacement System
STAR	Space Transportation Analysis And Research
SUA	Special Use Airspace
TACAN	Tactical Air Navigation
TCAS	Traffic Alert And Collision Avoidance System
TDLS	Tower Data Link Services
TDW	Tower Display Workstation
TDWR	Terminal Doppler Weather Radar
TFM	Traffic Flow Management
TMA	Traffic Management Advisor
TMC	Traffic Management Center
TML	Television Microwave Link
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
TSO	Technical Standard Order
TWIP	Terminal Weather Information For Pilots
UHF	Ultra High Frequency
URET	User Request Evaluation Tool
U.S.C.	United States Code
VASI	Visual Approach Slope Indicator
VDL	Very High Frequency Data Link
VFR	Visual Flight Rules
VHF	Very High Frequency

VOR	VHF Omni-Directional Range
VPD	Vehicle/Pedestrian Deviation
VPN	Virtual Private Networks
WAAS	Wide Area Augmentation System
WAN	Wide Area Network
WARP	Weather And Radar Processor
WIC	Weather In Cockpit
WIS	Workload Information System
WJHTC	William J. Hughes Technical Center
WMSCR	Weather Message Switching Center Replacement
WSDDM	Weather Support To De-Icing Decision Making
W/X	Weather

APPENDIX B.   DEFINITIONS

B.1   CATEGORY DEFINITIONS

Functions

Communication-subject areas dealing with the overall design, interface, systems, standards, validation and system safety that allow the exchange of information through various mediums. Mediums can include, but are not limited to, two-radios: VHF, UHF, HF (air-air, air-ground, ground-ground), Data Links, "land-lines", telephone, SATCOM, light signals, and signage, etc.

Navigation- subject areas dealing with the overall design, interface, systems, standards, validation and system safety that provide or assist in the capability of going from one place to another, determining position, and providing route solutions. Forms of Navigation may include Radio Navigation (GPS, INS, VOR/DME, Omega, Loran, NDB), Pilotage, and Dead Reckoning.

Surveillance- subject areas dealing with the overall design, interface, systems, standards, validation and system safety that provide the capability of locating, interrogating, and determining position in respect to azimuth, altitude, range, and velocity. Surveillance may be accomplished by conventional radar, visual acquisition, satellites, and self-position broadcasting systems (ADS).

Automation- subject areas dealing with the overall design, interface, systems, standards, validation and system safety that reduce the overall workload of the human aspect in systems. Automation systems may include DSS (Decision Support Systems), controller workstations, conflict resolution developers, flight data processing, etc.

Weather-subject areas dealing with atmospheric conditions, changes, predictions, and modeling. Some weather system evaluators may be satellites, radar, weather balloons, Doppler radar, etc.

Maintenance & Facilities-subject areas dealing with the overall design, interface, systems, standards, validation and system safety that address the dynamic challenge and planning of maintaining already existing resources. Resource examples: radio navigation facilities, surveillance sites, controller terminals, airports, towers, centers, etc.

Domains

Flight planning- all subjects dealing with the creation and implementation of a flight trajectory. This includes access to and availability of aircraft and environmental data

Airport surface- all subjects dealing with the planning and implementation of airport surface traffic. This includes planning and monitoring of airport traffic, intra airport communications, and availability of airport environmental data and aircraft state data as pertains to airport traffic

Departure and arrival service- all subjects dealing with the planning and implementation of departures and arrivals. This includes predicting and implementing runway allocations for takeoff and landing, dissemination of environmental data to ease planning, and methods to increase navigation accuracy for better flow management

En route/cruise- all subjects dealing with the planning and implementation of aircraft paths between takeoff and landing. This includes creating more flexible aircraft paths, conflict detection and resolution,

communication of environment and traffic data to aircraft and ground, traffic monitoring, more accurate navigation methods, and prediction of traffic conditions

Oceanic ops- all subjects dealing with the planning and implementation of aircraft paths over oceanic regions, in which monitoring is more sparse and the pilots are more responsible. This includes long-range and satellite data links and surveillance, more accurate navigation methods.

NAS management- all subjects dealing with the management of NAS resources. This includes the creation of broad scope restrictions and rules, evaluation of long-term initiatives, more collaboration between all affected parties, system-wide infrastructure, and traffic flow management infrastructure (monitoring and dissemination of information)

Management- all subjects dealing with the management of hardware and data resources. This includes a shift to local management of hardware resources and national information system, training, and support across organizational boundaries

Systems

Airborne Systems- A program that addresses airborne systems will focus on in-flight aircraft equipment and systems. This will include avionics, mechanics, airframes, crew, and cargo (including passengers).

Space Systems- A program that addresses space systems will focus on satellite based systems that are used for communication, navigation, surveillance, etc. These systems may work in conjunction with both ground and airborne systems.

Ground Systems- A program that addresses ground systems will focus on communication, navigation, surveillance, or weather systems and personnel that are based on the ground. It is possible that certain systems have a ground component and another component that falls into another system area (i.e. WAAS). In that case the system will be categorized into BOTH system areas.

Areas

Human Factors- A program that addresses human factors will focus on the performance of human beings in relationship to their environment. This relationship includes human interaction with aviation systems as well as with other human beings.

Performance Measurement- A program that addresses performance measurement will focus on the technical characteristics (timing, fuel savings, efficiency, accuracy, improved safety) of a given system, technology, or policy.

Economic Impact-A program that addresses economic impacts will focus on the financial impact of an aviation related system, technology, or policy. The financial analysis will not just assess the cost of a given innovation but also attempt to quantify the potential benefits of the system (improved performance, new abilities, etc.) in terms of dollars saved across the NAS.

Other-Programs that do not fall into the areas of human factors, performance measurement, or economic impact will be classified as other. It is also possible that programs will partly fall into one of the above areas and partly fall into the OTHER category. In that case, the program will be categorized in BOTH categories.

B.2   MAPPING RATINGS

Yes (Y)- required capability is addressed by the program or product. The research and development of this program has the intent of addressing the operational requirement.

Partial (P)- required capability is supported by the program or product. The research and development of this product does not directly address, but supports, a future operational requirement.

Extensible (E)- required capability could be addressed by the product. The research and development of this product does not currently address this future operational requirement, but it could, if the objectives are redefined.

No (N)- required capability is not applicable to the specific operational capabilities of the research and development or the product.

B.3   CATEGORIZATION RATINGS

Y# program results potentially have very great impact on the category factor.

Y+ less impact than Y++

Y significant impact. This is also the selection when no relative significance is defined.

Y- less than significant impact but not superficial.

Y= superficial impact.

N not related.

APPENDIX C.   LEVEL 1 CONCEPT OF OPERATIONS AND CATEGORIZATION

APPENDIX D.   RESEARCH AND DEVELOPMENT PROGRAM CATEGORIZATION

APPENDIX E. MAPPING OF PROGRAMS TO LEVEL 1 CONOPS

APPENDIX F. MAPPING OF LEVEL 1 CONOPS TO PROGRAMS

APPENDIX G.   CONTACT LIST

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Honeywell Business and Commuter Avit. Systems	BCAS Phoenix Location: 5353 W. Bell Road Glendale, AZ 85308		(602)436-8000	
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Motorola Government Electronics Group	Scottsdale, Arizona		http://www.mot.com/GSS/SSTG/F eedback.html	
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NORTHROP GRUMMAN CORPORATI ON Norden			1840 Century Park East Los Angeles, CA 90067 Telephone: 310-553-6262 Fax: 310-201-3023, 310-553-2076	

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Raytheon Company	141 Spring Street Lexington, Massachusetts 02173 USA		http://www.raytheon.com Tel 781.862.6600 Fax 781.860.2520 rscweb@raytheon.com.	
Rockwell International Corp. Air transport G/A GOVT systems		Customer Services M/S 112-110 Collins Air Transport Division Rockwell International Corporation 400 Collins Road NE Cedar Rapids, Iowa 52498-0001	Product Managers (319) 295-5000	http://www3.collins.rockwell.com/government-systems/ www.cca.rockwell.com www.rockwell.com
Rockwell		Address: P.O. Box 833807 Richardson, Texas 75083-3807	Operator Phone: (972)705-0000 Main Fax: (972)705-3398	Product Information Hotline voice:(800)321-2223 fax:(319)295-4777 or collins@collins.rockwell.com
Sandia National Laboratories	PO Box 5800 Albuquerque, NM 87185-(mail stop)			
Science Applications International Corporation	10260 Campus Point Drive San Diego, CA 92121		(619) 546-6000 phone (619) 546-6800 fax	
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Trimble Navigation Systems	Austin, Texas		http://www.trimble.com/cgi/f eedback.cgi	
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